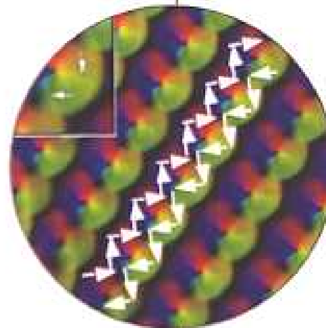
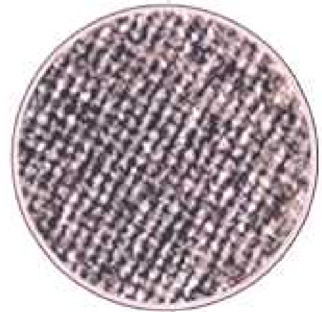
Conceptual
Design
Report

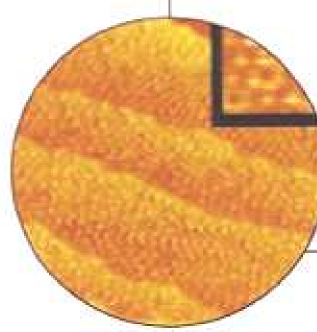
Project No. 04-CH-108

January 2003

Center for Functional Nanomaterials







Center for Functional Nanomaterials
Brookhaven National Laboratory

BROOKHAVEN
NATIONAL LABORATORY

Conceptual Design Report

BNL Center for Functional Nanomaterials

Brookhaven National Laboratory

Project No. 04-CH-108-0

for the

U.S. Department of Energy

Brookhaven Group

Prepared by: Brookhaven National Laboratory
Plant Engineering Division

BNL Approval:

1/27/03

M. J. Bebon — Date
Assistant Laboratory Director, Facilities & Operations
Brookhaven National Laboratory

1/27/03

D. Gibbs — Date
Interim Associate Laboratory Director, Basic Energy Science
Brookhaven National Laboratory

DOE-BAO Approval:

for — 1/27/03

R. Desmarais — Date
Brookhaven Area Office
U.S. Department of Energy

January 2003

Table of Contents

SECTION 7. PROJECT COST ESTIMATE

EXECUTIVE SUMMARY

1

SECTION 1. EXECUTIVE SUMMARY

This project will establish a Nanoscience Research Center at Brookhaven National Laboratory (BNL). The Center will be focused on the synthesis and understanding of functional materials, hence its name The Center for Functional Nanomaterials (CFN). It will be organized and operated as a user facility with particular emphasis on the national university community. The Center for Functional Nanomaterials will be housed in a new building, containing six laboratory clusters and will provide access to beamlines at the National Synchrotron Light Source. Its scientific program will be organized into five scientific thrust areas, aligned along specific functional materials, with a sixth thrust area in applications of these materials. These applications will emphasize emerging technologies of interest to the DOE's mission goals. The Center for Functional Nanomaterials will also provide major new directions to BNL's materials- and chemical-research, and greatly expand our university and industrial interactions. The Center's scientific goal is to provide the intellectual and experimental basis for tailoring a new generation of functional materials based on nanomaterials synthesis and educate the next generation of researchers in nanoscience and nanotechnology.

A. MISSION NEED

Significance to Brookhaven National Laboratory:

The Center for Functional Nanomaterials (CFN) will serve as the nucleus of an integrated BNL program in nanoscience. It will facilitate major new directions in BNL's materials and chemical research programs, and greatly expand the capabilities available to a national user base, thereby increasing our university and industrial interactions. It will enable us to focus the efforts of organizations within BNL by promoting complementary, interdisciplinary work, including the Chemistry Department, the Materials Science Department, Condensed Matter Physics, the Instrumentation Division, the National Synchrotron Light Source Department, and the Biology Department. The Center will also integrate BNL's unique capabilities in a broad range of synchrotron techniques, including hard and soft x-ray scattering and spectroscopy, with new materials synthesis and nanofabrication capabilities at BNL. The Center will serve as a focal point for collaborations, enabling studies of functional materials at the nanoscale involving academia and private industry, particularly in the Northeast, thereby catalyzing a new approach to materials research at BNL.

DOE Relevance:

The mission of the DOE Basic Energy Sciences (BES) program – a multipurpose, scientific research effort – is to foster and support fundamental research in focused areas of the natural sciences in order to expand the scientific foundations for new and improved energy technologies and for understanding and mitigating the environmental impacts of energy use. As part of its mission, the BES program plans, constructs, and operates major scientific user facilities to serve researchers at universities, national laboratories, and industrial laboratories.

In fulfilling its mission, the BES program has taken the lead within the Department of Energy (DOE) with the National Nanotechnology Initiative (NNI). The research plan for the NNI was developed by the Interagency Working Group on Nanotechnology, committee of the National Science and Technology Council. In a similar timeframe, the BES program issued the report "Nanoscale Science, Engineering and Technology Directions" (referred to as NSET). Both the NNI and the BES NSET reports recommended the initiation of Nanoscale Science Research Centers (NSRCs), which were deemed essential for conducting research in support of the DOE missions. The Center for Functional Nanomaterials (CFN) at Brookhaven National Laboratory (BNL), the only NSRC proposed for the northeastern United States, is a cornerstone of these NNI and BES program plans. The mission need was approved in June 2002 and the current scope has not changed since that time. The BNL CFN's scientific theme is *atomic tailoring of functional nanomaterials to achieve a specific response.*

The potential to tailor the properties of a material structured on the nanoscale is driving a revolution in materials science. This control immediately lends itself to the creation of new basic building blocks for nanodevices that exploit these enhanced properties. The NSRCs are critical, in part, because the impact of nanoscience discoveries will depend on our ability to link across multiple length and complexity scales. This linking from molecular interactions to nanostructures to functional systems is a challenge of the first order, both scientifically and technologically. Emerging approaches of lithography and replication extend to 50 nanometers, providing the opportunity to form a seamless integration of nano- and microtechnology. Bringing together the broad range of processing tools, instrumentation for characterization, and technical expertise needed to span and integrate these length scales is a significant challenge. The NSRCs will also provide a unique environment for the exploration of new nanoscience developments and allow students, faculty, industrial researchers, and national laboratory scientists to work together to propose, design, and assemble these materials into useful devices.

An overriding need is to provide an organizational infrastructure open to external users based on peer review that will enable and promote a truly national nanomaterials effort, thereby creating breakthrough opportunities. The NSRCs also provide a long-term commitment to the solution of significant research problems and to the development of a new generation of researchers equipped to explore the properties of science and technology at the nanoscale.

The resulting Nanoscale Science Research Center for Functional Nanomaterials (CFN) at BNL satisfies the criteria in the BES NSET Program for NSRCs. Specifically, the CFN will:

- advance the fundamental understanding and control of materials at the nanoscale,
- support the users community, encompassing individual investigators and small groups, with access to major equipment and advanced labs including technical support and potential collaboration,
- optimize the use of a BES national user facility, i.e., the NSLS, as well as the new instrumentation available in the CFN,
- provide a formal mechanism for both short- and long-term collaborations and partnerships for DOE laboratory, academic, and industrial researchers,
- train graduate students and postdoctoral research associates in interdisciplinary nanoscale research, in cooperation with academic institutions,

- build on the core competencies at BNL in physics, chemistry, instrumentation, and materials science, with plans to incorporate the biological sciences,
- complement other NSRCs, as well as the four regional NSF nanocenters,
- partner with state governments and local institutions,
- advance the strategic vision of BNL, and
- serve as a coordination center for nurturing cooperative ventures involving researchers from surrounding universities and industries.

B. CFN SCIENTIFIC FOCUS AND OBJECTIVES

The often remarkable change in properties of a materials structure on the nanoscale is the key factor driving the nanoscience revolution. In addition, the ability to nanostructure materials offers the potentially irresistible advantage of providing novel – and enhanced – materials properties in a form that immediately lends itself to forming new basic building blocks for nanodevices – devices that utilize these enhanced properties. One materials class with a particular need for new and enhanced properties is that of functional materials, that is, materials that perform specific functions. Many of the applications of the next generations of functional materials ranging from magnetism to piezoelectricity to catalysis, are expected to be driven by, and utilizing, advances in our understanding of the fundamental nanoscale physics and chemistry. This revolution is well underway for semiconductor materials, which exhibit the now well-studied changes of density of states and electronic structure when reduced in size to dimensions approaching several atomic lengths. These, in turn, alter their electronic response and have led to new types of optical and electronic devices. In the Center for Functional Nanomaterials, we will examine a much wider range of materials and materials properties; many of these have not heretofore been examined in nanoscale form. Thus, our CFN will examine functional materials such as piezoelectrics, ferroelectrics, organic conductors, magnetic nanocomposites and catalysts in their nanoscale form. Here, the effects of nanostructuring go beyond the confinement effects present in semiconductors. We will attempt to understand the nanoscale physics and the resulting materials physics. The fundamental questions to be addressed involve understanding new correlation effects, the new dynamical effects of elementary excitations, and chemical reactivity in nanoscale objects. To achieve this, we bring into play powerful materials probes based on electron accelerator sources and microscopy. The ultimate goal is to provide a detailed, fundamental understanding of the nanoscience of these new material properties and the various synthesis routes required to make them, and use this understanding to tailor new and unexplored materials for future applications.

Specifically, the focus of the CFN will be the nanoscale materials chemistry and physics of functional materials. Functional materials are at the heart of a wide range of emerging technological applications such as sensors, activators, memory, and energy-generation devices. The response of useful functional materials can arise from a variety of physical phenomena. For example, in catalytic materials, reactivity can be affected by the presence of certain surface sites or by the band structure of the materials. In ferroelectric- or piezoelectric-materials, the response can be enhanced by the proximity of the operating conditions to a phase transition, such as a metal-insulator transition. In each of these examples, the functional response is known to be highly sensitive to the details of the atomic- and electronic-structure of the material. This structure may be influenced by phenomena occurring at longer length scales. Therefore, an adequate understanding of, and control over, the properties of functional materials require investigation of the variation of their composition and structure over a variety of length scales, ranging from Angstroms to tens of nanometers.

Many recent studies have established that, when material structures are fabricated with nanoscale dimensions, it affects the chemical and physical response. Thus, for example, nanoscale metallic particles have a very different chemical and physical response than the corresponding bulk phases of the same materials. In fact, the bond and changes in nanoscale metal particles leads to a distinctive material state insofar as their chemical reactivity is concerned. The Center, proposed here, is aimed at understanding the chemical and physical response of nanomaterials, with the challenge being to attain the level of understanding needed to tailor or design new classes of functional materials.

The CFN programs will exploit the unique electronic and optical properties of nanoparticles and molecular nano-arrays to design chemical systems with specific functionality for diverse, energy-related applications such as catalysis, solar-photo conversion and storage, and molecular conductors. Another emphasis will be to examine the behavior and fundamental properties of functional nanocomposite materials including ferro-electrics, magnetic and superconducting thin films to provide insights into their future applications. Still other emphasis have been documented in the proposal establishing mission need. This approach is complementary to the other planned NSRCs; it capitalizes on the National Synchrotron Light Source (NSLS) leadership in new materials probes, and builds on the strengths of BNL's BES multi-disciplinary programs in (1) strongly correlated electron systems, (2) catalysis, (3) molecular materials, (4) electrochemistry, (5) nanostructure in complex functional materials, and (6) charge transfer processes in condensed media.

Initially, the CFN will focus on six scientific areas: 1) Strongly correlated oxides: examining changes in the electronic response of metal oxide nanomaterials, 2) Magnetic Nanoassemblies: investigating magnetic interactions in nanomaterials, 3) Nanocatalysts Materials: studying ways to form catalysts – materials used to speed chemical reactions – and examining their electronic structure and reactivity, 4) Charge Injection and Transport: studying electronic conduction in molecular wires, nanocrystals, and nanodots, 5) Nanostructured Organic Films: investigating how thin organic films self-assemble into structures that have better mechanical, electronic, and optical properties, and how these films could be used as lubricants, adhesives, and to enhance chemical reactivity, and 6) Applications of Nanomaterials: building new devices, such as nanoscale electronic materials, ultra-thin film optical devices, and advanced fuel cell catalysts.

In the CFN, a wide range of synthetic approaches will be explored to tune the photo or chemical activity and other properties of nanoscale objects through control of particle size, density, molecular functionality, and chemical environment. In addition, the CFN will house an expanded electron microscopy facility, a nanopatterning capability, access to specialized NSLS beamlines, a powerful suite of unique proximal probes for directly imaging atomic and molecular structure, ultrafast laser sources for nanomaterials excitation and probing, and a center for theory and modeling.

C. CFN DESCRIPTION

The project scope includes the design and construction of a laboratory building and the acquisition of the required instrumentation to support the nanoscience thrust areas and laboratory functions that are identified in Section 2, Technical Facilities.

The CFN structure will be a two-story building of approximately 85,000 square feet, housing clean rooms, wet and dry laboratories, office space for CFN staff and users, and conference rooms. The building will incorporate human factors into its design so as to encourage peer interactions and collaborative visits between BNL staff and users. In addition to offices and laboratories, it will house "interaction areas" for informal discussions and lunch rooms on each floor to foster scientific discourse. This design approach will provide state-of-the-art in research facility design. Material and system selections will address the principles of sustainable design to insure low energy and maintenance costs over the life span of the building. Design features will be incorporated into the building design that account for the sensitivity of nanoscience instrumentation, i.e., vibration isolation, temperature controls to +/-1.0 F degrees and shielding from electromagnetic interference.

The CFN will operate through major laboratory clusters: these are facilities for nanopatterning fabrication, ultrafast optical sources, electron microscopy, materials synthesis, proximal probes surface characterization, theory and computation, and an endstation at an NSLS beamline optimized for nanoscale characterization using small angle scattering. An initial set of scientific equipment for these laboratories will be purchased as part of the project. The NSLS provides a wide range of imaging, spectroscopy, and diffraction/scattering techniques. In order to take advantage of these features, including the NSLS endstation, the CFN Users will have assured access to a suite of existing beamlines at the NSLS including: soft x-ray microscopy beamlines; UV, soft and hard x-ray spectroscopy beamlines; soft and hard x-ray scattering beamlines; an infrared spectro-microscopy beamline; an undulator insertion device microprobe beamline; and an undulator insertion device nanoprobe beamline.

The BNL Center for Functional Nanomaterials will be a structure integrated with the existing NSLS and Instrumentation facilities to complement the existing functions of these facilities. Siting of the Center will take advantage of proximity to the Instrumentation Division (Building 535), the Physics (Building 510), Materials Science (Building 480), and NSLS (Building 725) Departments, which are key interdisciplinary participants in nanoscience research.

The Center for Functional Nanomaterials will integrate existing BNL capabilities including in its synchrotron characterization techniques, its LEAF electron source, and its growing electron imaging facilities with new materials synthesis, imaging, materials temporal probes, and nanofabrication capabilities. The CFN will draw on the experience and infrastructure of the existing NSLS User Program, which handles more than 2500 users per year, to establish an active CFN User Program, including both individual and cooperative ventures. At full capacity, we estimate that 300-500 users will work at the CFN each year.

D. BUDGET

The project cost estimate in at-year dollars, including escalation and burden, is $85 million with obligations of $4.1 million in FY 2004, $22.9 million in FY 2005, $42.8 million in FY 2006, and $15.2 million in FY 2007.

WBS 1.0	BNL Center for Functional Nanomaterials		
WBS 1.1	Project Support		$ 8,287,000
	Project Management - Design	$ 1,008,000	
	Project Management - Construction	1,818,000	
	Project Engineering - Design	3,852,000	
	Project Engineering - Construction	1,609,000	
WBS 1.2	Technical Construction		$ 33,447,000
	Nanopatterning	$ 7,791,000	
	Ultrafast Optical Sources	3,666,000	
	Electron Microscopy	9,461,000	
	Materials Synthesis	4,428,000	
	Proximal Probes	6,288,000	
	Theory and Computation	627,000	
	CFN Endstations at NSLS	1,186,000	
WBS 1.3	Conventional Construction		$ 27,337,000
	Improvements to land	$ 889,000	
	Building	22,789,000	
	Utilities	3,659,000	
WBS 1.4	Standard Equipment		$ 1,317,000
	Contingency		$ 14,612,000
	Project Cost Summary		$85,000,000*

*(Escalated, At-Year Dollars, Rounded to Nearest $1,000
Includes BNL's indirect costs of $ 6,208,000)

E. PROJECT MILESTONES

The baseline project schedule is based on the standard DOE budget cycle and assumes Title I start in FY 2004.

The proposed baseline project schedule includes the following milestones:

NEPA Approval	03/26/02 (A)
CD-0 Approval	06/12/02 (A)
Approve CD-1 Preliminary Baseline	03/31/03
Technical Construction	
Technical Design Start	08/02/04*
Approve CD-3 Start of Procurement	12/31/04*
Procurement Start	01/03/05
Technical Design Complete	05/31/06*
Procurement Complete	12/29/06
Installation and Testing Start	01/02/07*
Installation and Testing Complete	11/30/07*
CD-4B – Approval	12/31/07*
Conventional Construction	
Start Title I – Preliminary Design	01/02/04*
Complete Title I – Preliminary Design	03/31/04
Title I - Approval	04/30/04
Approve CD-2 Performance Baseline	05/28/04*
Start Title II – Detail Design	06/01/04
Complete Title II Detail Design	10/29/04*
Title II – Approval	11/30/04
Approve CD-3 Start of Construction	12/31/04*
Award Contract	02/28/05
Issue Notice to Proceed	04/01/05
Start Construction	05/02/05*
Complete ORE for Occupancy	11/30/06
Complete Construction	12/29/06*
CD-4A – Approval	01/31/07*

*Major Milestone

(A) Actual

TECHNICAL FACILITIES

2

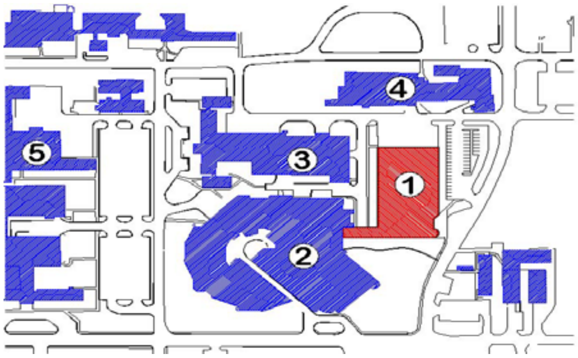
SECTION 2. TECHNICAL FACILITIES

A. OVERVIEW

The Center for Functional Nanomaterials (CFN) provides the nucleus for an integrated BNL program in nanoscience and nanotechnology. It will focus and enhance the efforts of departments at BNL doing nano-related work, including the Chemistry Department, the Materials Science Department, the Condensed Matter section of the Physics Department, the Instrumentation Division, the Biology Department and the National Synchrotron Light Source Department.

As a major user facility, the impact of the CFN will be enhanced by the presence of several other BES user facilities located nearby. CFN users will have the advantage of being able to access a variety of techniques to address a range of scientific issues during a single visit. Toward this end, we are planning that a single proposal will allow access to the main BES facilities at BNL. These include Laser Electron Acceleration Facility (LEAF), the MSD electron microscope facility, and, of course, the NSLS. LEAF permits sample reactions to be initiated by short electron pulses, with monitoring of electron transfers using time-resolved spectroscopy. Presently, the electron microscope facility features a 300 keV transmission electron microscope with a field emission gun. The CFN will seek to integrate the unique capabilities of the NSLS in a broad range of structural and spectroscopic techniques, encompassing IR, UV, and soft and hard x-rays, with the new material and nanofabrication capabilities at the CFN.

Additionally, the CFN will serve as a platform for collaborations in studies of functional materials at the nanoscale with nearby universities, industrial laboratories, as well as the NSF-funded nanocenters. The CFN's physical presence will consist of a new building located adjacent to the existing BNL NSLS and Instrumentation Division buildings (see Figure 2-1). Because of this proximity location, in-situ monitoring of growth and processing chemistry will be feasible. The CFN will also include new user and collaborative space for our research partners from universities and other institutions. Finally, the facility site has been chosen to be consistent with BNL's long term strategic planning criteria. The CFN will be located in BNL's core program research area and thereby maximize use of the adjacent existing facilities.



1. BNL CENTER FOR FUNCTIONAL NANOMATERIALS
2. NATIONAL SYNCHROTRON LIGHT SOURCE DEPT.
3. INSTRUMENTATION DIVISION
4. MATERIALS SCIENCE DEPARTMENT
5. PHYSICS DEPARTMENT

Figure 2-1. Location of the BNL Center for Functional Nanomaterials

The new two story CFN building of approximately 85,000 gross square feet will include clean rooms, general laboratories, and wet and dry laboratories. It will also provide individual offices, user space and computer access for visiting collaborators, as well as conference areas and informal meeting areas. The building will integrate human factors into it’s design so as to encourage peer interactions and collaborative visits by staff surrounding the CFN. It will feature “interaction areas” for informal discussions, a meeting and lunch room, in addition to office space. The CFN will be state-of-the-art in research facility design.

The scientific facilities within the building are organized into Laboratory Clusters. These provide the basic technical capabilities to be offered by the CFN in order to accomplish a range of scientific goals. The clusters represent the single largest component of the CFN, and will make up the core of the scientific staff. The laboratory clusters include facilities for: 1) Nanopatterning, 2) Ultrafast Optical Sources, 3) Electron Microscopy, 4) Materials Synthesis, 5) Proximal Probes and 6) Theory and Computing. In addition, the CFN will also operate a Laboratory Cluster designated 7) CFN Endstations at the NSLS. The Clusters are described in more detail in part B of this section.

In order to fulfill its role as the premier user-oriented nanoscience research organization in the northeastern US, it is essential that the BNL CFN (a) support the development and operation of advanced equipment as a service to users as well as, (b) encourage cutting-edge nanoscience research.

Function (a) of the CFN program is addressed by the Laboratory Clusters. The primary responsibilities of Cluster personnel are to develop and maintain the advanced equipment and to provide support for CFN users. The equipment and personnel of the seven Laboratory Clusters will enable BNL scientists, and academic and industrial users to carry out scientific investigation into nanomaterials with unprecedented tools and capabilities. It is emphasized that the Cluster Laboratory personnel assume prime responsibility for user service at the CFN, and have been most directly associated with the CFN design.

We have sought to focus the scientific program at the CFN, as well as to enhance its vitality and attractiveness to General Users by selecting scientific Thrust Areas. The Thrust Areas, outlined in part C of this section, represent new areas of research at BNL that grow out of existing strengths in BNL BES-funded programs. The Thrust Areas are complementary to the research areas emphasized at other DOE Nanoscale Science Research Centers, and are intended to encourage cutting edge nanoscience research. Support for Thrust area research is based on the premise that these entities are vital to Outreach. Thrust area research groups will develop and sustain external collaborations. The major theme of the BNL CFN, "atomic-level tailoring of a material's response to achieve a specific functionality", spans all six Thrust Areas, acting as a unifying theme of the proposed CFN research. They include; 1) Strongly correlated oxides: examining changes in the electronic response of metal oxide nanomaterials, 2) Magnetic Nanoassemblies: investigating magnetic interactions in nanomaterials, 3) Nanocatalysts: studying ways to form catalysts—and examining their electronic structure and reactivity, 4) Charge injection and transport: studying electronic conduction in molecular wires, nanocrystals and nanodots, 5) Nanometer-thick organic films: investigating how thin organic films self-assemble into structures that have better mechanical, electronic, and optical properties, and how these films could be used as lubrications, adhesives, and to enhance chemical reactivity, and 6) Nanoscience applications: building new devices, such as nanoscale electronic materials, ultra-thin film optical devices, and advanced fuel cell catalysts.

The Laboratory Cluster designs and scientific equipment are specified based on needs identified within the scientific Thrust Areas and consistent with the obligation to provide service to users. These were determined through a series of breakout sessions led by Thrust Leaders at CFN Workshops. Flexibility is incorporated into the designs to allow for and accommodate new emerging areas of research. For example, the facility is designed for Biological Hazard Level 2, in order to accommodate biological nanoscience research at a later stage.

B. LABORATORY EQUIPMENT AND DESCRIPTIONS

The functions that will be performed by the seven Laboratory Clusters, including the "CFN Endstations at NSLS" Cluster, are discussed in the following sections. Descriptions of the significant research instrumentation and equipment contained in these Laboratory Clusters are also provided. In the cluster descriptions below, the more significant equipment may also name manufacturer and model to help define the capabilities desired for the cluster laboratories.

1. Nanopatterning

The Nanopatterning Cluster will employ state-of-the-art electron beam, ion beam, and deep ultraviolet patterning; plasma deposition, gas vapor deposition, and vacuum deposition; plasma, wet-chemical etching and appropriate packaging methods to fabricate nanoscale materials with precision. The facility will respond rapidly to user fabrication requests, allow open access for detailed analysis of fabrication phenomena, and maintain sufficient flexibility to incorporate novel nanoscale fabrication processes now under preliminary investigation. Initially, the lithography facility will support BNL Thrust Areas, Strongly Correlated Oxides, Nanocatalyst Materials, as well as Charge Injection and Transport.

Multi-Functional nanocomposites are heterogeneous materials that have been engineered on the nanoscale to detect and process information or to otherwise perform as active agents to transform one physical property to another. Ferroelectrics, piezoelectric, superconductors, and magnetic materials are among the many classes of materials under active investigation. Although fabrication methods such as molecular self-assembly or atomic manipulation have received much recent publicity, the most direct approach for nano materials synthesis is thin film deposition combined with electron beam lithography.

Lithography-based methods are also important for Nanocatalyst Materials chemistry. Using lift-off techniques and high aspect ratio plasma etching methods, unique substrates can be fabricated that maximize surface area and enhance the distribution of catalytic particles. These surfaces serve as ideal platforms for in-situ observation of catalytic processes using high resolution transmission electron microscopy and scanning probe microscopy. Conductance of molecular wires, self-assembled metal nanoclusters, or carbon nanotubes can be accurately measured only if patterned projections with nanoscale dimensions can be fabricated to both suspend the molecular wire and bond securely to its ends. This "attachment problem" in nano-electronics must be effectively solved if computers on the molecular scale are to become a reality.

This fabrication effort also requires extensive use of techniques, aside from nanopatterning, that either deposit or remove a few atomic layers of material. Most nanostructures fabricated by lithography involve a complicated sequence of material deposition, patterning, and selective removal of material. Chemical vapor deposition, vacuum sputtering, e-beam evaporation, deep reactive ion plasma etching, molecular beam epitaxy, and focused ion beam etching are all examples of processes that can be controlled with nanometer precision. After the fabrication steps are complete, the physical dimensions, electrical, magnetic, and mechanical characteristics of the completed nanostructures must be measured with a precision equal to that attained during patterning and deposition. Surface profilers, atomic force microscopes, specialized scanning electron microscopes, and sensitive probe stations will be utilized for this precise characterization. With all of these elements in place (nanoscale patterning, a diverse array of surface deposition and etching methods, and nanoscale metrology) the CFN will have a powerful resource to leverage its expertise in functional nanomaterials research.

In addition to supporting the CFN Thrust Areas, the nanoscale lithography facility will be of immediate benefit to several ongoing research projects at nearby institutions. At Stony Brook University, efforts requiring nanofabrication include x-ray optics for experiments at the NSLS (Jacobsen), single electron memories and nanoscale ballistic MOSFETS (Likharev), hybrid semiconductor-superconductor nanostructures (Mendez), and quantum dot unipolar lasers (Luryi). A technique known as high-aspect-ratio nanofabrication may be applicable to studies in microfluidics (J. T. Yardley, Columbia University).

The Nanopatterning Cluster will advance and provide an understanding of nanoscale materials as well as of nanoscale device development in such fields as electronics, photonics, and biochemical sensors. The Cluster will remain vital by insuring that process development occurs in tandem with device fabrication. The cluster will be a magnet for consortia with the SUNY Centers for Advanced Technology in Sensors, Biotechnology, and Thin Film Research at Stony Brook and Albany, and the Columbia University MRSEC Nanocrystal Research Center.

The following paragraphs summarize the major equipment items selected for initial installation at the Nanopatterning Cluster of the CFN. Where appropriate, these facilities will be supplemented with equipment for thin film deposition, metrology, and testing already available from the BNL Instrumentation Division.

Electron Beam Pattern Generation

Electron beam lithography is used to fabricate nanostructures in a variety of materials, and is a key component in the Nanopatterning Cluster. State-of-the-art e-beam systems use an accelerating voltage of 100 keV to write the smallest possible structures (10 nm line width) with minimal electron side-scattering in photoresists. The JEOL 9300FS system utilizes

- a high rate deflection system with writing speeds of 25 MHz,
- laser interferometer with 20 nm placement accuracy,
- dynamic control of focus and beam position for 1 nm placement writing accuracy over a 0.5 mm field, and
- a 1 nA current for high writing throughput.

These tools can pattern sections of large diameter (300 mm) wafers directly with e-beam resists. For higher throughput applications, masks can be used in UV exposure tools for bulk exposure of wafers.

Electron Beam Patterning Support Equipment

Electron beam lithography provides the means to generate a nanoscale pattern. The preparation of the photoresist to receive the pattern is essential for nanostructure patterning. Modern programmable spin-bake development systems like the EVG150 station completely automate each step of the resist development process to achieve reliability and reproducibly. Components essential for nanoscale patterning also include spinners that run multiple wafer diameters and have programmable dispense arms, vacuum hotplates that clamp wafers for precise thermal baking cycles, and developer modules with spray, stream, and puddle modes.

Deep Reactive Plasma Etching

Nanostructures must generally be formed from the underlying substrate by a process such as deep reactive ion etching. This is an extremely versatile technique that enables nanoscale structures to be etched in silicon with aspect ratios as high as 50:1. While the primary etched structure must be silicon, this technique can be used to form a mold, allowing for fabrication of nanomaterials by additional vacuum or wet chemical deposition steps, followed by silicon removal. State-of-the-art deep reactive ion etch systems use environmentally acceptable fluorine based chemistry with cooled tables that allow the formation of either vertical or sloped sidewalls. A system like the specified Oxford Plasma Lab etcher is modular with shared pumping stations to permit expansion with additional vacuum plasma process equipment.

Focused Ion Beam Etching and Metrology

Because metrology is intimately tied to fabrication, an instrument that combines the analytical metrology and sequential patterning functions in a single package is needed. In the FEI Focused ion beam metrology tool, a high resolution scanning electron beam and an ion beam of gallium work in concert. The nanoscale areas of interest are first identified, then ion-milled for morphology studies and elemental analysis. The focused ion beam milling technique is precise enough to prepare thin sections for transmission electron microscopy in a wide range of materials. Since the ion beam is programmable, and has a minimum spot size of 7 nm, it can be used to sequentially pattern many classes of functional nanomaterials directly, without resorting to multiple step procedures.

2. Ultrafast Optical Sources

The Ultrafast Optical Source Cluster will provide a suite of techniques probing the structure and dynamics of nanostructured systems on the femtosecond time scale. Several laser systems will serve a number of experimental stations, configured for different nonlinear optical probes and femtosecond pump-probe geometries, offering researchers the broadest range of available techniques. Many ultrafast techniques now under development show great promise for nanoscience applications. Examples include terahertz spectroscopy, novel single shot measurement techniques, ultrafast near field microscopy, and ultrafast short wavelength sources. The Cluster is structured for the active development of these techniques and their rapid inclusion as methods available to researchers at the CFN.

The Cluster can be divided into three areas, nonlinear optical probes, femtosecond pump-probe methods, and new sources and techniques. Though the boundaries among these divisions are obviously soft (for example, nonlinear responses may be used in pump probe configurations), they provide a convenient framework for discussing the operation of the Cluster in the narrative below. The Ultrafast Optical Source Cluster is designed to offer a large number of varied techniques and to be able to tailor them appropriately to meet the demands of multiple and simultaneous users. Two ‘workhorse’ (4 mJ) laser systems will be equipped with appropriate frequency synthesis and timing setups, with their light directed to a number of experimental stations, each of which can be independently reconfigured while experiments take place at neighboring stations. In this way, not all techniques are available simultaneously, but any particular technique can be brought online quickly, allowing a high degree of parallel operation and versatility. A third laser, the R&D system, is devoted primarily to development, and is also situated to deliver light to experimental stations when needed. Most user needs will be met by the 4 mJ pulse energy of the workhorse systems. However, a power amplifier will be located so that it can be used by either the R&D system or one of the 4 mJ systems. The amplifier will be used on the R&D system in studies of short wavelength sources.

Nonlinear Optical Probes

Nonlinear optical probes primarily exploit the high peak intensity of ultrafast systems. The nonlinear response of the sample to the strong optical fields is strongly dependent on local composition and structure, creating a probe which can isolate surface effects from bulk response, interrogate interface dynamics at boundaries between nanostructures, identify local conformational changes within a sample, probe local fields, or reveal other symmetries.

This section comprises a large number of techniques, some of the most common being second- and third-harmonic generation (SHG, THG), and sum and difference frequency mixing (SFG, DFG). Because several of these tools have proven to be very powerful across a wide range of nanoscience fields, they are included in this Cluster.

Since they are ideally suited for in-situ studies, nonlinear optical probes will play an important role in Nanostructured Organic Films Thrust Area. Many of these materials, though designed at the molecular level, can be grown by relatively simple techniques in the liquid phase. Studies of their growth and chemistry under relevant ambient conditions require probes to penetrate solvents. For example, understanding the dependence of the kinetics of the self assembly of organic thin films upon solvent, temperature and mixing conditions is important to optimizing growth. Other target areas in which surface sensitive nonlinear spectroscopies can play an important role include nanowetting, the effects of chirality on adsorption kinetics, templated surface patterning reactions, and photoinduced chemical dynamics relevant to nanopatterning. Second harmonic magneto-optical Kerr effect spectroscopy (SH-MOKE) is an important tool within the Magnetic Nanoassemblies Thrust Area, while the sensitivity of nonlinear spectroscopy to the spin, charge, orbital, and lattice degrees of freedom have made it an ideal probe of symmetries in the Strongly Correlated Oxides Thrust Area.

Femtosecond Pump-probe Methods

Femtosecond pump-probe methods exploit the ultrafast character of electronic transitions: nanostructured systems show interesting dynamical behavior on time scales from femtoseconds to milliseconds and beyond, and optical pump-probe techniques provide unique ways in which to study phenomena over this whole range.

Pump-probe methods are perhaps the most powerful tool for understanding dynamics. Ultrafast laser systems offer the best time resolution, but are especially versatile in these applications for several other reasons. It is possible to derive multiple wavelength sources from a single master oscillator using simple nonlinear frequency synthesis techniques (harmonic generation, parametric amplification, etc). Thus, inherently synchronized pump and probe beams can be obtained at wavelengths ranging from the deep ultraviolet to the far infrared. Simple shaping techniques exploiting the large coherent bandwidth can be used to create complex temporal waveforms as well. Self-phase modulation techniques can also be used to create short pulses with very broad bandwidth, allowing time resolved absorption spectroscopy (white light continuum spectroscopy). Ultrafast techniques offer the capability of essentially complete control over all of the properties of the pump and probe beams.

These techniques also find wide application in nanostructured systems of interest to the BNL CFN. Within the Strongly Correlated Oxides Thrust Area, where the strong coupling between spin and charge excitations is critical to material properties, the ability to probe optically in both time- and spectrally-resolved ways has proven to be a powerful tool for understanding the interaction dynamics. In addition, excitation and charge carrier dynamics in Nanostructured Organic Films Thrust Area are also effectively studied using ultrafast pump-probe techniques.

New Sources and Techniques

In order to exploit new opportunities, it is essential that the Cluster be prepared for the development of new ultrafast sources and techniques. While the precise projects may change in the few years before the CFN is completed, the desired direction is clearly one that expands the accessible wavelength range, enhances the attainable spatial and temporal resolutions, and develops novel techniques that address problems peculiar to nanoscience research. Accordingly, the Ultrafast Optical Source Cluster will develop, in collaboration with the Proximal Probes Cluster, a femtosecond apertureless near field scanning optical microscope, which should achieve simultaneous femtosecond and nanometer scale resolution. Ultrafast laser driven short wavelength sources, both coherent and incoherent, will be pursued, to extend probe wavelengths to the extreme ultraviolet and soft x-ray regime. The coherent short wavelength sources may extend temporal resolution to the sub-femtosecond level. At the other end of the spectrum, terahertz spectroscopy is a promising technique, particularly in correlated electron systems, where selectively probing low energy excitations is advantageous. Finally, single shot pump-probe techniques need to be developed, since, in many experiments, only small amounts of sample can be synthesized, and these degrade rapidly with exposure.

3. Electron Microscopy

Thanks to the recent advances in electron optics aberration correction and quantitative electron microscopy instrumentation, a new generation of transmission electron microscope (TEM) can now be designed and built. These instruments will be capable of image resolution better than 0.1 nm and spectroscopic resolution better than 1 eV. The instruments will allow the design of special purpose sample stages that convert a microscope to a true experimental nanomaterials laboratory. With such microscopes, planned for the Electron Microscopy Cluster, we can conduct various experiments crucial to nanoscience and technology, ranging from in-situ sample fabrication and structural characterization to property measurements on a nanoscale. Possible areas for technique development include, but are not limited to:

- advanced phase reconstruction methods based on the transport-of-intensity equation and electron holography to measure charge, potential and magnetization distribution at the nanoscale;
- a straining sample stage to study polarization, phase transformation and dynamic behaviors of ferroelectric and magnetic domains, and their interaction with defects;
- nanoprobe column by column electron energy-loss spectroscopy with simultaneous acquisition of high-resolution images;
- quantitative electron diffraction to accurately measure local strain and lattice displacement;
- quantitative high resolution imaging, dynamic image simulation and interpretation;
- nanocrystallography with determination of interfacial structure;
- nanoscale low concentration chemical mapping; and
- TEM based electron beam lithography.

In addition to providing support for CFN users and Thrust Areas, the Cluster staff will also interact with researchers from other BNL organizations, including Condensed Matter Physics, NSLS, and the Materials Science Department.

Specimens used in the transmission and scanning transmission electron microscopes must been thinned to electron transparent thickness while minimizing damage. Specimen preparation is a craft and often labor intensive. Especially in the case of nanoscale structures, physical damage and changes in the microstructure can easily occur if the materials are not prepared with utmost care. Multiple sets of sample preparation equipment are needed to ensure that samples can be prepared concurrently even when one set of equipment is under repair.

Scientific capabilities and accomplishments anticipated for the proposed state-of-the-art instruments include 3-D atomic imaging and structure determination of nanoassemblies, a nanoscale understanding of magnetism and ferroelectricity in controlled temperature and field conditions, visualization of dislocation interactions in nanostructures under controlled stress, elucidation of grain boundary motion under stress in nanocrystals, exploration of chemical reactions on small catalyst particles, and imaging of defects in the oxygen sublattice of complex oxides.

200 kV TEM-FEG

A state of the art 200 kVJEOL JEM 2100F, will feature a field emission source, a specially designed monochromator and spherical aberration correctors for both objective and condensor lenses, an energy filter, and a stage with tilt angle range of $\pm 40^{o}$. It will be used for versatile high resolution structural properties analytical purposes.

Nano Analysis Electron Microscope

The second instrument will be a high resolution microscope capable of delivering accurate microanalysis on low Z elements (including Be). The system will be well equipped with software, including packages designed to perform microanalysis on biological specimens.

Scanning Electron Microscope

The JEOL 7400F type 1 scanning electron microscope will permit chemical analysis and imaging at the nanoscale. A well equipped scanning electron microscope with field emission gun provides access to nanostructure and elemental analysis down to the 1 nm scale. Both energy dispersive and wavelength dispersive spectrometers are specified, as well as a crystal mapping system (Inca Crystal 200 EBSD).

Sample Preparation Lab

The following sample preparation equipment will be available:

- focused ion beam system;

- sputter coaters for depositing metal films; carbon coater;
- ultramicrotomes; precision dimpler;
- wire saw; diamond saw for slicing; ultrasonic, disc, and rotary slurry cutters;
- polishing wheels; tripod polishers; dimpler/polisher;
- plasma cleaner; twin jet electropolisher; ion mills; chemical thinning; and
- high resolution optical and digital microscopes.

4. Materials Synthesis

The Materials Synthesis Cluster is designed to provide a range of thin film, bulk, and soft material synthesis capabilities. Analytical and characterization equipment constitute a major portion of the investment. These items complement not only the synthesis efforts based within the Cluster, but directly support the other Cluster laboratories in the CFN.

Thin film fabrication is facilitated with a molecular beam epitaxy (MBE) system, a pulsed laser deposition (PLD) system for oxide films, and a basic evaporator for thin metal layers. Bulk preparation facilities, including arc melting and crystal growth via induction, may be used to prepare bulk crystals for their intrinsic scientific interest or for use as substrates or targets in film preparations. A wet chemistry preparation lab will be used for generation of highly uniform precursors and for fabrication of nanoparticles.

The characterization tools included within this Cluster are essential to the nanofabrication effort. A metallography lab will allow the evaluation of microstructures, as well as the preparation of specimens for scanning electron microscopy in the Electron Microscopy Cluster. Conventional x-ray diffraction work is a daily necessity for preliminary characterization. At first glance, the x-ray lab included here might seem redundant with the NSLS at close hand. However, the NSLS beamlines are primarily reserved for specialized experiments for which preliminary x-ray characterization has already been obtained. In addition the NSLS has month-long maintenance periods. Magnetic, transport and thermal characterization equipment will be incorporated and utilized intensively. The chemical analysis tools include a system for evaluation surface area (and/or particle size), as well as high pressure liquid chromatography.

Molecular Beam Epitaxy

An MBE (Veeco Applied Epi Mod. Gen. II) system is planned for fabrication of film samples. This system will be available for user projects that will involve electron microscopy, NSLS characterization, as well as other capabilities of the CFN. The growth chambers will offer 15 keV and 50 keV Reflection High Energy Electron Diffraction (RHEED) heads and residual gas analyzers. Evaporation sources have been tentatively specified for this phase of the project, but may be revised subsequent to consultation with the emerging developing user community.

E-Beam Evaporator

A basic 3kW e-beam evaporation station will allow metallic coatings to be applied to specimen surfaces. The material evaporation source can be changed based on user needs.

Pulsed Laser Deposition

The PLD system features a Lambda Physik Excimer Laser. The system complements the semiconductor (MBE) and metal (e-beam) capabilities, being primarily designed for the fabrication of oxide films.

Arc Furnace

A tri-arc furnace with crystal pulling will permit the fabrication of single crystal and polycrystalline intermetallics of many descriptions. One application of the facility will be to grow custom substrates for thin film depositions. A potential application (after some modification) would be to generate carbon nanotubes.

Bridgman Crystal Growth/Induction Heater

The Crystalox MCGS5 provides a facility for producing crystals that are heated using magnetic induction. The resulting crystals, when cut and polished, may be used for thin film substrates.

X-ray Diffraction Lab

This basic laboratory based powder diffraction system is chosen to complement the more advanced and specialized facilities available through the NSLS. The Materials Synthesis Cluster requires ready access to analytical diffraction for quick characterization not regularly available at the NSLS.

Metallography Lab

The metallography lab provides the ability to process and inspect specimens. Cutting, mounting, and polishing permit the fabrication of surfaces, which is a prerequisite to investigation by the optical metallograph as well as study in the SEM.

Thermal Measurements

TGA/DTA and DSC provide access to information about phase transitions, melting, and uptake or loss volatile components of bulk samples. Such information is used, for example, to establish processing parameters such as temperature and ambient atmosphere.

Magnetometer

A MPMS Xl7 magnetometer is used to characterize magnetic and superconductor specimens. This essential information is obtained using easily managed computer controlled experimental procedures.

Inorganic and Polymer Preparations

An array of equipment, including glove boxes, centrifuge, spincoater, pumps, and circulator will be available for inorganic and polymer synthesis. A viscometer will be provided for characterization of fluids.

BET-Surface Area by Adsorption

This technique is used to estimate particle sizes from surface area. It can be used to determine "control" parameters as part of an evaluation of intermediate products or as characterization of finished agglomerates.

High Pressure Liquid Chromatography

Chromatography is a chemistry technique that permits the identification, by "fingerprinting" of components in solution. The chromatograph will permit the quick and accurate characterization of materials.

5. Proximal Probes

Recent developments in scanning probe microscopy (SPM), which includes scanning tunneling microscopy (STM), atomic force microscopy (AFM), magnetic force spectroscopy (MFM), and near-field scanning optical microscopy (NSOM), have stimulated new directions in the physical sciences and engineering, and have revolutionized surface science. The great advances in sensitivity and spatial resolution of SPM-based instruments have had a tremendous impact on research in such diverse areas as biology, geology, space exploration, microelectronics, material science, physics and chemistry.

The Proximal Probes Laboratory Cluster will provide state-of-the-art capabilities in scanning probe techniques, such as STM and AFM, as well as optically-based confocal and near-field microscopies, for developing the next generation of scanning probes based on spectroscopic “chemical” imaging. The Proximal Probes Cluster includes four fully instrumented SPM laboratories and an ancillary wet chemical laboratory for sample preparation and analysis. Two laboratories are dedicated to the development of new SPM techniques and their application. Many of these new techniques will be strongly coupled to scientific interests represented by the related Thrust Areas. For example, the development of an STM capable of operating under high pressure and high temperature conditions is of particular interest to the Nanocatalyst Materials Thrust Area for in-situ characterization of nanostructured catalysts under reaction conditions.

These characterizations will be conducted in the high resolution SPM laboratory, which is focused on atomic resolution STM/AFM and promising new developments in low energy electron microscopy (LEEM). The second development laboratory will focus on ultra-spectromicroscopy techniques, which are based on apertureless, near-field approaches to coupling spectroscopic chemical probes (e.g., Raman, IR) with the high spatial resolution of AFM. These spectromicroscopy techniques will find application in wide range of user experiments for which indexing chemical information with spatial topology is important, e.g., polymers, composites and biomaterials.

A third laboratory is dedicated to user SPM instruments including a UHV variable temperature STM for surface science studies, an environmental SPM with a variety of scan modes (STM, contact and non-contact/tapping AFM) for liquid and electrochemical systems and a combination near-field and SPM instrument for optical imaging of nanostructured materials or biological samples. The fourth laboratory is dedicated to optical characterization of nanomaterials by specially configured IR/VIS/UV spectrometers, an FT-IR confocal microscope, and two combination SPM optical microscopes, one with confocal and one with near-field capabilities.

Near Field Scanning Optical Microscopy

Two near-field optical scanning microscopes a Veeco Aurora III and a Nanonics NSOM/SPM 100, will be used for optical imaging of nanometer scale materials. Both instruments include SPM scanning capabilities for topological scanning in contact and noncontact modes. The Aurora III represents the state-of-the-art in electronic tip control and spatial resolution (30-50 nm) and can be used in reflectance and transmission modes. The Nanonics combination NSOM-AFM is specially designed to allow Raman scattering detection through interfacing with components of the Renishaw Raman microscope (see below).

Fourier Transform IR Microscope

A Bruker Equinox 55 FT-IR spectrometer working in the near and mid-IR (400 – 7500 cm^{-1}) will be equipped with an IR confocal microscope

(Hyperion 2000) for transmittance and reflectance FT-IR imaging of samples. This instrument will be used for survey imaging of mesoscopic structure of materials such as polymers and biomaterials with chemical sensitivity provided by IR vibrational spectroscopy. Two dimensional chemical imaging is accomplished by precision scanning the sample. The FT-IR will also handle other solid, liquid or gas samples for routine IR analysis and will include an FT-Raman option using the 1064 nm fundamental of an internal Nd:YAG laser. The FT-Raman capability provides chemical characterization of solid samples or solutions (e.g., colloids) that strongly adsorb in the infrared and are inaccessible by FT-IR transmission or reflection.

UV-VIS-NIR Spectrometer

A Varian Cary 5000 UV-VIS-NIR spectrophotometer (175–3300 nm) will be used for spectral analysis of solids and liquids via transmittance, and specular and diffuse reflectance. Applications include size vs. band gap measurements for semiconductor quantum dots suspended in solution and survey spectra acquisitions to identify vibronic absorption features which can be used as a basis for species identification or spectral analysis via resonant excitation (e.g., UV Resonance Raman).

Raman Microscope

A Renishaw RM1000 VIS-UV confocal Raman microscope will be used as a platform for developing spectroscopic techniques for optical imaging in apertureless near-field scanning microscopy. The use of shorter wavelengths is desired to improve the confocal spatial resolution (diffraction limited) and increase the sensitivity via enhancements of the Raman scattering process (e.g., resonance excitation). A high power cw, intracavity-doubled Ar-ion laser (Coherent, FreD) will be used to generate visible (514 nm), near UV (488 nm) and deep UV (257 nm, 244 nm) radiation for use with the Raman microscope.

Environmental Scanning Microscope

A wide range of nanomaterials is expected to require nanoscale imaging that can be routinely provided by tabletop SPM's with STM and AFM (contact and noncontact/tapping) capabilities. Two such instruments will be provided by the Proximal Probes Cluster. Both the Veeco Explorer and the Accurion Ultraobjective will have dry and liquid sample capabilities, as well as fully integrated optical microscopes for visual inspection and alignment.

UHV Variable Temperature STM

A general purpose Omicron UHV STM with variable sample temperature capabilities (25 K to 1500 K) will be provided for studying the surface structure of materials with atomic resolution. Such an instrument is ideally suited to study the structure of thin films and nanoparticles or arrays generated via physical or chemical vapor deposition or by MBE techniques. The wide temperature range also allows the study of dynamic processes such as growth, diffusion, and reaction induced reconstruction. The instrument will include a full complement of preparation and characterization tools (sputtering, Auger, LEED), CVD and high temperature evaporation sources, as well as a fast entry chamber for sample exchange.

UHV Low Temperature STM

Dedicated low temperature (<10 K) STM instruments play an increasing role in fundamental atomic resolution, mode-specific studies of surfaces. This Omicron instrument is the only one currently available which permits a direct visualization of individual adsorbed surface species and their characterization by electronic and vibrational spectroscopy. With these capabilities, chemical reaction on surfaces can be controlled with atomic level precision.

Low Energy Electron Microscope

The Elmitec low energy electron microscope uses electrons to image surfaces with a resolution better than 10 nm in both real space and diffraction mode over a wide range of temperature. This occurs in real time due to the parallel image acquisition. A combination of this instrument with a synchrotron-based photoemission beamline will provide a unique and powerful instrument for element-, structural- and time-resolved imaging of surface chemical reactions and surface transformations.

Ultra High Vacuum Nanoprobe

The Omicron UHV Nanoprobe provides the user with multiple SPM capabilities in a UHV compatible instrument that includes a fully integrated secondary electron microscope (SEM) for topographical imaging of surfaces with a spatial resolution of better than 10 nm. The instrument consists of four independent scanning SPM heads and a central sample stage onto which the SEM can be focused. In addition to having variable temperature STM capabilities, one of scanning heads will be a true AFM head using optical beam deflection for optimum resolution. The combination of SEM and AFM imaging will be especially powerful for investigating 3-D nanostructures, such as metal nanoparticles, which are notoriously difficult to image using a constant current STM. The instrument will also include a full complement of preparation and characterization tools (sputtering, Auger, LEED), CVD and high temperature evaporation sources, as well as a fast entry chamber for sample introduction.

6. Theory and Computation

The Theory and Computing Laboratory Cluster was conceived to provide state-of-the-art software and computational facilities for users as well as a path for interaction between users and the theoretical community at BNL and beyond.

Many of the experiments contemplated for the CFN will require the generation of new analysis and visualization tools, which bridge recent developments in both commercial and research level software. Experimentalists are becoming increasingly involved with modeling and will have to perform relatively sophisticated calculations in order to interpret experimental data. Codes such as first-principles density functional and Monte Carlo are becoming increasingly popular. There is also a need for graphics, data libraries, image processing software and networking.

The study of nanoscale materials will require more complex data analyses since, in most cases, the geometrical structures are less ordered and therfore more complex. The experiments on nanomaterials, including, for example, transmission electron microscopy (TEM) or x-ray scattering, will be more challenging to interpret. In many cases, density functional theory has the capability to provide calculated geometrical structures. The CFN will therefore provide a variety of first-principles density functional methods including full potential linear augmented plane wave (FLAPW), pseudopotential, and methods based on local orbitals. Often, density functional methods are insufficient and a variety of ab-initio quantum chemistry codes including MOLPRO and Gaussian will also be available. There is also a need for codes that are integral to data analysis, including Rietveld for x-ray diffraction, as well as packages designed for extended x-ray absorption fine structure (EXAFS), TEM, and optical spectroscopy.

Theoretical and computational components of several Thrust Areas will be closely related to the activities of this Laboratory Cluster including Magnetic Nanoassemblies, Nanocatalyst Materials, and Charge Injection and Transport in Nanoscale Materials. We also anticipate strong interactions between the CFN Theory and Computing Cluster and the BNL Center for Data Intensive Computing as well as with the BNL Institute for Strongly Correlated and Complex Materials.

Theory and Computational Equipment

An integral part of the CFN will be the hardware to carry out many of the computations described here. A Linux cluster computer, with approximately 200 processors will be able to handle large background calculations and, at the same time, can be shared among users for routine tasks. In addition BNL has excellent internet connectivity to major DOE Computational Centers such as NERSC (National Energy Research Scientific Computing Center).

7. CFN Endstations at NSLS

The NSLS is one of the premier synchrotron radiation sources in the world, hosting more than 2500 user scientists annually. The NSLS operates two storage rings, and provides bright electromagnetic radiation from far infrared (< 1 meV) to hard x-rays (> 100 keV). A wide range of experimental techniques, including imaging, spectroscopy, diffraction, and scattering, are readily available for advanced characterization of materials.

To facilitate access to these tools at the NSLS, CFN staff will be trained in relevant synchrotron techniques. Initially, the CFN will develop one endstation (described below). This participation will permit the CFN to act as a "partner user" at the NSLS facility. Based on the CFN "partner user" status, CFN users will have access to a selection of NSLS capabilities, and the CFN will be able to administer CFN user access. The following is a list of endstations that will be grouped into a nanoscience consortium:

- Soft and hard x-ray microprobe,
- IR endstations,
- Soft and hard x-ray spectroscopy,
- Soft and hard x-ray scattering/diffraction, and
- Small angle scattering.

A state-of-the-art small angle scattering endstation will be constructed by the CFN. Small angle x-ray scattering (SAXS) is the most important experimental technique for determining the size, shape, and internal electron density distribution of nanoparticles, and correlations among nanoparticles. In comparison with scanning probes and transmission electron microscopy, which can also provide information on particle size and shape, SAXS is particularly important in providing accurate statistically-averaged information and is adaptable to in-situ studies. This in-situ capability enables the real-time study of the growth of nanoparticles and nanocomposites. This provides information crucial for optimizing the production of these nanoscale materials.

Recently, an in-vacuum 3.7 mm gap undulator with undulation period of 12.5 mm was installed at the NSLS x-ray ring. The device conforms to the design specifications and has no adverse effect on the machine lifetime. This successful and unique insertion device opens up the possibility for two additional undulator beamlines, using the space between the radio frequency cavities. The NSLS plans to construct a new dedicated small angle scattering beamline using this in-vacuum undulator technology, incorporating optics optimized for small angle scattering. This new beamline will be 100 times brighter than the existing bending magnet beamlines. The increased brightness and flux of this new beamline will enable improvements to many of the time dependent studies outlined in the scientific programs of the CFN, especially in two of the NSET proposals submitted by BNL to the DOE Office of Basic Energy Sciences, "Charge Injection and Transport in Nanoscale Materials" and "Nanoscale Functional Materials: the Role of Scale and Dimensionality". Furthermore, the new beamline will have the capability to carry out anomalous small angle scattering measurements. By tuning the energy to an absorption edge, anomalous measurements can selectively probe the correlation around one specific element in the system. This technique can also be used to reduce scattering contributions from the solvent or matrix materials so that signal-to-background ratio can be improved to allow the effective study of dilute systems.

The small angle scattering CFN endstation will be located on the new in-vacuum undulator beamline to be constructed by NSLS. The endstation will have microfocusing capability with spatial resolution of ~10 μm for the study of inhomogeneous systems. It will also have the capability for grazing incidence small angle scattering for the study of nanowetting and a wide range of structured organic thin films. The following is a list of the major components of this endstation:

- Area detector (The most critical component for the endstation is a 2-D detector with fast read-out times and small pixel size. A leading candidate for such a detector is the MAR CCD, which is currently in use at several NSLS endstations. This detector has an active diameter of 165 mm, a pixel size of 15 μm^2, and a fiber-optic taper delivering a demagnification of 2.7:1);
- Position sensitive detector and high speed electronics;
- Soller slit systems for high angle x-ray scattering;
- Grazing incident small angle scattering optics;
- Sample chambers and positioning stages;
- High power optical microscope, associated optical components, and motorized mounting stage (the high power optical microscope will be

used for precision alignment of the x-ray beam and sample); and

- Motorized slits, table, detector arm, and controls.

C. SCIENTIFIC FOCUS OF THE CFN

The scientific focus of research at the BNL Center for Functional Nanomaterials will be the chemistry and physics of functional nanoscale materials and the parallel development of new nanoscale materials probes, particularly involving the NSLS and the emerging high resolution TEM facility. The nanoscale structures, interactions, and properties of functional materials will be studied to provide the scientific basis for the design of future functional materials and devices. The six research directions (Thrust Areas) areas described in part C represent major new areas of research for BNL, but are well matched to existing strengths in chemistry, physics, and materials science research at BNL. The Applications of Functional Nanomaterials Thrust Area will provide additional outreach from the CFN to academia, research laboratories, and industry. A brief summary description of each of these Thrust Areas is given below.

1. Functional Nanoscale Materials: Strongly Correlated Oxides

This Thrust Area represents a coherent effort to prepare, characterize, and pattern nanoscale oxides including ultrathin films and nanoparticles. Patterning of oxide surfaces will be accomplished i) through creating vicinal surfaces, by directly injecting electronic charge into nanoarrays, and ii) by fabricating nanometer surface relief structure on the surface of the oxide crystal.

As sample dimensions are reduced, completely different properties -- and in fact, new materials -- often result from confinement, with the alteration of strong electron interactions. These properties arise through a mechanism quite different from that of quantization associated with nanometer dimensions. Quantization effects, in fact, play a secondary role in strongly correlated systems. Rather, the primary effects are due to the long range Coulomb interactions, such as electron screening from external, polarizable media, and the long range Madelung potential, that cause dramatic changes at surfaces and interfaces of strongly correlated materials. Thus, a finite size strongly correlated object can exhibit behavior quite counterintuitive to expectations based on quantum size effects. Closely related to the issue of confinement is the role of surfaces and interfaces in controlling the behavior of finite sized strongly correlated systems. It also has recently become clear that the origin of many of the physical phenomena exhibited by bulk complex oxides, including resistivity, magnetization, thermal conductivity, and magnetoresistance, lies in the nanoscale behavior and correlations present in these materials. Thus, properties may be manipulated at the nanoscale by creating nanoparticles or ultrathin films.

To understand these issues, we will undertake basic structural characterization of ultrathin oxide films and nanocrystals, as well as determine transport and magnetic properties. The basic structural symmetry of these samples must be determined, but it is clear that additional information, including chemical, structural, and mechanical homogeneity are crucial nanoscale parameters. Significant progress in understanding these phenomena, however, requires that the growth and characterization of samples be carried out in a highly collaborative mode, with fast feedback and iteration between the synthesis and characterization. Developing such a synergy is essential to the rapid advancement of oxide nanoscience and will be accomplished in this Thrust Area.

2. Magnetic Nanoassemblies

Future magnetic materials will be based on multiphase systems designed to interact with one another cooperatively over the nanometer lengths that characterize the interaction scale of magnetic materials. The interaction scale is known as the “exchange length” and is extremely sensitive to subtle alterations in the atomic registry, chemical and strain environments surrounding magnetic entities. Therefore complete characterization of the nanostructure in complex multiphase magnetic systems is integral to the understanding and technological exploitation of this class of materials. Many of the identifying characteristics of magnetism at the nanoscale level can be found in nanoparticle and nanoarray systems, collectively termed “magnetic nanoassemblies”. To elucidate the detailed physical factors that determine the static and dynamic response of magnetic nanoassemblies, the Magnetic Nanoassemblies Thrust Area will characterize and model the interactions and factors affecting them. The specific questions of fundamental importance in the study of magnetic nanoassemblies that are addressed in this Thrust Area are as follows:

- What is the ground state of magnetic nanoassembly systems as a function of their geometry, dimensionality, and scale?
- How do magnetic interactions propagate over nanometer length scales?
- How does the nature of the boundaries or interfaces of components of magnetic nanoassemblies affect the magnetic response?

In all cases the magnetic ground state of magnetic nanoassembly systems is determined by a delicate balance between short range magnetic exchange forces and longer range magnetostatic and magnetostrictive forces. The issues delineated above will be addressed in the Magnetic Nanoassemblies Thrust Area by bringing together expertise in the synthesis, characterization, and modeling of magnetic nanoassemblies. It is anticipated that magnetic nanoassemblies that span the size range from groups of atoms to bulk materials will be made with different, but related, compositions and synthesized with geometries amenable to studies with advanced experimental and computational techniques. These systems may be discrete single phase systems, such as arrays of magnetic nanoparticles or magnetic nanowires, or they may be multiphase systems of disparate chemical compositions. For example, theoretical and experimental approaches will attempt to understand the collective behavior of atoms constituting individual clusters of tens of atoms and of thousands of atoms; of arrays of nanoparticles or nanowires and of magnetic nanoparticles dispersed in a matrix of a different magnetic character. Experimental results obtained from studies on these materials systems will be used to refine theoretically- and computationally-derived results. In this manner it is anticipated that new insights into the fundamental behavior of magnetic nanomaterials will be attained and used to create new and as yet unimagined functional devices.

3. Nanoscale Catalyst Materials

   The BNL Nanoscale Catalyst Materials Thrust Area centers on the preparation, characterization, and catalytic reactivity of metal-containing nanoparticles in a wide variety of chemical environments. We are particularly interested in exploring the reactivity of novel nanomaterials, such as mixed metal oxides, sulfides, carbides, and phosphides that are expected to provide the next generation of catalysts for industrial and end user environmentally sensitive processes. The main objective is to optimize catalytic action by identifying the characteristics of these metal-containing clusters or particles, i.e., their size, composition, and the chemical environment. This effort will rely on the Laboratory Clusters to provide structural characterization via scanning probe and electron microscopy facilities, materials growth, nanolithography for substrate templating, and computational facilities for modeling the electronic structure, geometry, and reactivity of nanoparticle systems. Instrument development is also an important cooperative activity between the Nanoscale Catalyst Materials Thrust Area and the Laboratory Clusters, particularly in spectromicroscopy for chemical imaging of heterogeneous materials, and the incorporation of high pressure capabilities in TEM, STM/AFM and NSLS's materials line characterization tools.

4. Charge Injection and Transport in Nanoscale Materials

   Because of their specific, tunable electronic properties, nanometer scale objects can perform a range of energy-related functions ranging from primary photoelectron acceptors/donors in photonic devices to catalysts in environmental cleanup. Thus, it is essential to have an understanding of charge transfer in and between molecular wires and nanoparticles, between bulk metals or bulk semiconductors and nanoparticles, and among nanoparticles, in order to effectively exploit new materials based on these components. Nanometer scale processes are a central theme, but the understanding of macroscopic transport also requires consideration of long range phenomena, such as percolation. Comprehensive models for these processes will encompass the interplay of such classic effects as percolation and Coulomb blockade due to capacitive coupling between nanoparticles, and quantum mechanical effects such as localization, tunneling, and energy level spacing.

Within the Charge Injection and Transfer Thrust Area, synthesis and characterization of nanomaterials will be key functions. This Thrust Area will extensively utilize the Laboratory Clusters, including Materials Synthesis, Electron Microscopy, Proximal Probes, Nanopatterning, and CFN Endstations at NSLS. Fundamental measurements of charge transfer will be compared to predictions of charge transfer and transport properties via models of electronic structures. The Theory and Computation Cluster will play a key role in this modeling work.

5. Nanostructured Organic Films: Structure and Self-Assembly

Organic films are an essential component of many key nanotechnologies, including tribology, protective coatings, molecular alignment for display- and optical-networking-device applications, organic-based electronics, biomimetics, and sensors. These thin organic films exist in a range of physical states, including chemisorbed solids, liquid crystalline states, or liquid states, e.g., wetting films. Because of the reduced dimensionality and a high surface-to-volume ratio of these films, the physical state may differ from the behavior of bulk material. A better understanding of the physical and chemical properties that stabilize nanometer thick films is essential. Control of these interfaces is crucial, not only for the applications mentioned above, but also for developing coatings for metal and semiconductor nanoparticles, and for creating multicomponent devices with lateral dimensions on the nanometer scale. Another important reason to pursue organic film technology lies in the vast potential for chemical functionality that can be implemented molecule-by-molecule, resulting in machinery of truly nanometer scale.

To incorporate soft matter and biological function into future nanotechnologies, it is necessary to understand the interplay between liquids and soft matter assembly at the nanoscale. Using state-of-the-art structural probes that are compatible with the liquid/vapor environment, we will generalize and adapt current descriptions of liquid, liquid crystalline, and bulk soft matter phases to the nanoscale. Many of the proposed investigations require the use of templated surfaces, with spatially varying height and chemical properties. X-ray scattering techniques will be used to probe the physical behavior of these thin films. The Nanostructured Organic Film Thrust Area will work in concert with university collaborators, many of whom have already contributed to the recently funded DOE/NSET proposal, "Nanotemplate Directed Assembly of Soft Matter and Biomaterials", for the development of the requisite nanometer scale templates. These collaborations have also been actively working with the NSLS to establish dedicated endstation facilities for investigating the structure of these nanoscale organic films.

6. Applications of Functional Nanomaterials

In this Thrust Area, we will explore the use of functional nanomaterials for a selected set of specific applications. This Thrust Area is of critical importance because nanoscience is a field in which applications typically go hand-in-hand with the physics and chemistry of new materials. Often, a comprehensive examination of both basic and applied aspects leads to new ideas that enrich both areas.

There are many examples of interactions of applied and fundamental science, including nanoscale catalytic materials and carbon nanotubes. Many of these emerging applications provide important new technologies to support the DOE mission. The research in the Applications of Functional Nanomaterials Thrust area will investigate fundamental aspects of the techniques and materials, developed elsewhere in this proposal, to advance a set of applied goals. Ferroelectric and piezoelectric materials may act as nanoscale electro-mechanical systems. While the Strongly Correlated Oxide thrust area might concentrate on the understanding and improvement of basic properties, the Applications of Functional Nanomaterials Thrust area could develop methods and materials to incorporate the ferroelectric or piezoelectric entity into a prototype device structure.

A second related value of such an approach is that it enables the CFN to expand its potential for scientific outreach. Thus, nanotechnology research allows the CFN to encompass a wider variety of scientists doing work in emerging areas of applied science, particularly within the northeastern region of the country. Many of these scientists have projects in which fundamental science is intimately wrapped into the development of new devices or applied techniques, and close interaction with Brookhaven's CFN will be of benefit to both. This arrangement also ensures contacts with a greater variety of research scientists and students.

CONVENTIONAL FACILITIES

3

SECTION 3. CONVENTIONAL FACILITIES

A. DESCRIPTION

The scope of conventional facilities for the Center for Functional Nanomaterials (CFN) project will include construction of an approximately 85,000 square feet, two-story lab/office building, improvements to the building site and installation of required utilities. The CFN building will include a number of unique construction features that are further described in Section 3.C. Special Construction.

The CFN building will be a steel frame and reinforced concrete two-story structure that is designed for added stiffness and resistance to vibration. The foundation will be reinforced concrete piers and perimeter gradebeam with fiberglass reinforced isolated slab on grade construction for the ground floor. The second floor will be steel-beam-and-girder-supported, concrete-filled metal decking. The roof will be metal decking supported on bar joists.

The exterior finish for the building will be pre-insulated metal architectural panel with thermal-pane fixed glazing. The roof will utilize an insulated 4-ply built-up membrane roofing system.

The interior layout of the CFN will accommodate a number of key functional requirements consistent with its mission as a regional user facility for research in functional nanomaterials. To enable the mission, we plan to:

- provide a mix of flexible laboratory space capable of supporting varied thrust areas in nanoscale research
- provide office space for CFN operating and research staff
- provide flexible (open plan) office space for users and collaborative research teams
- provide support space for utilities and supporting services that does not compromise the stringent environmental requirements of the laboratory spaces
- provide meeting and interaction areas that foster free exchange of ideas and leverage scientific creativity

The general layout of the CFN places laboratory spaces in the interior of the 1st and 2nd floors seeks to minimize impacts from sunlight, temperature variations and noise. Office space and interaction areas are on the exterior to maximize use of daylight and provide a more pleasant work environment. A loading dock, mechanical room and gas cylinder storage room are located at the rear of the building and are structurally isolated to prevent transmission of vibration. A service corridor, running the full length of the lab spaces on both floors, is provided to enable servicing of most lab utilities and support equipment without entering the lab space. A structurally isolated mechanical equipment penthouse runs the length of the roof over the service corridor to provide an enclosure for laboratory ventilation equipment.

The location of the CFN proximate to the National Synchrotron Light Source (NSLS) and Building 535, Instrumentation Division, was selected in part by the need for frequent interaction and transfer of experimental specimens between these three buildings. To accommodate this need, a connecting corridor to the NSLS from the 1st floor of the CFN is provided and an elevated covered walkway connects the 2nd floor of the CFN to Building 535. The elevated walkway allows continued access of delivery vehicles to the shipping and receiving area of the NSLS, which has been incorporated in the connecting corridor structure.

The planned space utilization for the CFN is:

	Number	Square Feet
Single Person Offices[3]	53	8,450
Multi-Person Offices	12	5,300
Flexible Office Space	10	10,750
Electron Microscopy Lab Spaces	5	5,800
Proximal Probe Lab Spaces	5	5,200
Nanopatterning Lab Spaces[1]	5	4,500
Materials Synthesis Lab Spaces[2]	5	5,850
Ultrafast Optical Source Labs	2	4,600
Theory & Computation Lab Spaces	1	1,150
General Purpose Lab Spaces	2	1,450
Conference Space & Library		2,700
Service & Support Space		29,250
	Total:	85,000

[1] Includes 1,170 SF of Class 1,000 clean room and 1,630 SF of Class 100 clean room.

[2] Includes 180 SF of Class 1,000 clean room.

[3] Office Space net SF/person = 120SF.

The CFN will be served by utilities from BNL's central utility systems. Electrical power will be provided by two new 1,500kVa Double-Ended substations connected to the BNL 13.8 kV distribution system. Connection to the central steam, potable water, sanitary, chilled water, compressed air, stormwater, fire alarm, communication and energy management systems will meet the balance of utility requirements.

It should be noted that the central chilled water system is currently at its maximum capacity and does not currently have spare capacity to meet the additional 500 ton load of the CFN. To provide the needed additional capacity, the CFN project will construct 650 tons of chilled water capacity in a satellite chiller plant in Building 555 that is connected to the central chilled water system. This satellite chiller plant will supply the central chilled water system with the additional peak load capacity needed to enable CFN connection to the central chilled water system. This approach provides the advantages of reliability and temperature stability of the central chilled water system to the CFN without the noise, vibration, Electro Magnetic (EM) Radio Frequency (RF) interference and space consumption that would arise if the chillers were installed in the CFN building.

B. SITING ALTERNATIVES

The location of the proposed CFN was selected based on a number of criteria and consideration of several alternatives. The major criteria considered were:

- Ability to comply with environmental requirements
- Ability to meet research mission objectives related to collaborative BNL research facilities in Bldgs. 725, 535 and 480
- Constructability related to site conditions, access to roadways and access to utilities
- Economic factors affecting project cost
- Conformance with BNL strategic planning goals
- Ability to support future expansion

The alternative sites considered are indicated on Figure 3-1. Consideration was also given to the feasibility of utilizing existing space at BNL and converting it to state-of-the-art laboratories for Nanoscale research. This approach was deemed not feasible due to the extremely poor condition of the available space and the fact that these World War II era wood-frame buildings are small, structurally inadequate and dispersed throughout the BNL site.

Location "A" on Figure 3-1, to the west of NSLS and Instrumentation Building 535, was determined to be unacceptable because it would require elimination of Technology Street, prevent access to the NSLS gas supply area, eliminate about 40% of available parking space in a heavily utilized area and present additional utility costs and major service interruptions due to the presence of a 20" chilled water main that would have to be relocated.

Location “B” on Figure 3-1, to the south of NSLS was determined to be unacceptable because it did not provide ease of access to either NSLS, Building 535 or Building 480 and would constrain strategic planning options for the NSLS Phase III Upgrade project proposed for the latter half of this decade.

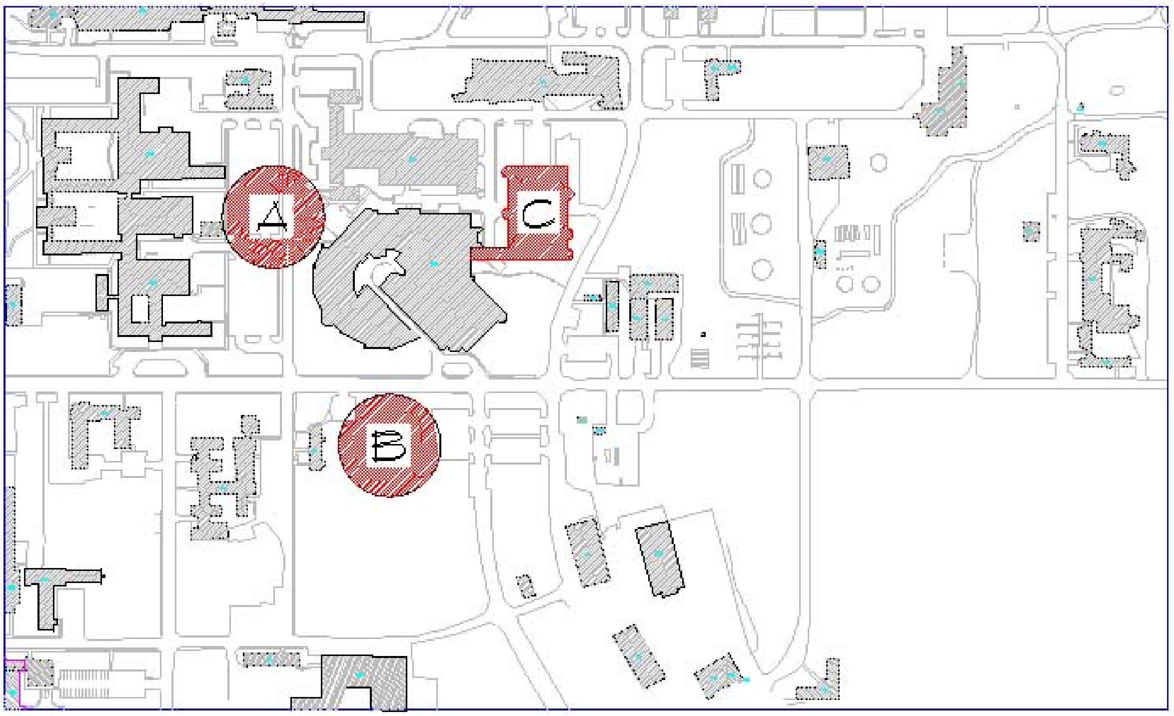


Figure 3-1

The site selected for construction of the CFN, indicated as “C” on Figure 3-1, meets all of the criteria indicated above and is superior to all alternative locations considered. The site enables connections to Building 535 and the NSLS and easy access to Building 480 Material Sciences. These facilities contain key collaborative research groups and experimental facilities that will help to foster the multi-discipline research teams envisioned for the CFN.

The site does not present any environmental impediments to construction and, conversely, will not be negatively impacted by the CFN either during construction or operation (see Section 5 for environmental evaluation). The site has no endangered species, wetlands or historical features that would be impacted by the CFN. A NEPA review has been conducted and this project has been deemed “Categorically Excluded,” meaning no further environmental review is required.

Constructibility at the site is excellent. The soil conditions are good for construction, access to utilities and roadways requires minimal distances and there is sufficient adjacent space for parking. The site has a slight slope, which enables good drainage and balanced cut and fill. It will be necessary to reroute some drainage utilities in the planned building footprint; however, this is a minimal effort.

The proposed site offers several economic advantages over other sites. Since proximity to utility systems is very good, the capital cost to construct and connect is relatively low. The gently sloping site enables use of on-site fill, eliminating the need for expensive off-site fill. The proximity to adjacent collaborative departments and the user support infrastructure in NSLS enable higher productivity and lower operating costs.

The proposed site conforms to BNL strategic planning goals and is presented in this location in the FY 2000 BNL Site Master Plan. Additionally, this location complements plans for future expansion of NSLS in the latter half of this decade with the proposed NSLS Upgrade Phase III Project.

The selected site enables future expansion of the CFN on the north and east sides. There is sufficient plot space to more than double the footprint of the CFN in its current two-story configuration. If further expansion is needed, there are plans to reroute Railroad Avenue under the NSLS Phase III Upgrade Project; that would make even greater expansion of the CFN possible if required.

C. SPECIAL CONSTRUCTION

The CFN will primarily be designed and constructed using conventional practices; however, there are some elements of the CFN's mission that will require unique design features and construction methods. The special design and construction elements are related to the need to minimize vibration, minimize interference from electromagnetic or radio-frequency sources (EMI/RFI), minimize temperature and humidity changes and minimize air turbulence for many of the CFN's research instruments. In addition to mission-driven features, the CFN will incorporate sustainable design elements as required to achieve a LEED's (Leadership in Energy and Environmental Design) rating.

The highly sensitive instruments required to conduct research at the nanoscale must operate in extremely stable environments to achieve their specified resolution. Sensitivity to external sources of vibration is a major consideration in the design and layout of the CFN to enable these instruments to achieve their rated performance. At the start of Title I design, a vibration survey of the CFN site will be conducted to determine the magnitude and extent of external sources of vibration. A vibration consultant will analyze the results and provide design recommendations to achieve the desired attenuation. To minimize vibration effects, the most sensitive instruments will be located on the ground floor and will be placed on structurally isolated reinforced concrete slabs. Slab thickness will be based on the sensitivity of the instruments and external sources of vibration. The building structure will be designed for maximum rigidity by using generously sized structural members, rigid connection details, and beam and girder framing of the second floor with 8″ thick concrete fill.

The CFN design will strive to eliminate creation of new sources of vibration wherever feasible. The loading dock, mechanical equipment room and mechanical penthouse will be structurally isolated from the building. Rotating machinery will be mounted on vibration isolators and ductwork and piping will be strategically fitted with vibration isolators and flexible joints. HVAC and piping systems will be designed to minimize sources of acoustic vibration. Elevators will be located at the far ends of the building away from lab spaces. Strict adherence to the commissioning plan will assure that machinery is properly balanced and supported to minimize sources of vibration. In addition, many instrument manufacturers provide vibration isolation mounts and/or pads for their equipment. These will be procured with the instruments as required to achieve the desired performance.

Experiments engaged in research at the nanoscale are susceptible to interference from electromagnetic or radio-frequency sources. The CFN will be designed to minimize the effect of these sources whenever possible. At the start of Title I design, an EMI/RFI consultant will perform a survey of the CFN site to determine existing sources of interference. These sources will be eliminated where feasible or minimized by the design of the CFN. Design features such as the insulated metal architectural panel exterior and metallic oxide coated thermal glazing make a significant contribution to reduction of external sources of RFI. The consultant will actively participate in design decisions related to cable type and routing, location and selection of electrical equipment, and routing and selection of ducting and piping materials. A post-construction EMI/RFI survey will be performed as part of the commissioning effort to assure that intended EMI/RFI mitigation has been achieved and to provide an operational baseline for the facility.

Thermal gradients, changes in humidity, and turbulent airflows can adversely affect the research sample and instrument performance. Precise temperature controls to ±1°F are required in several CFN laboratories, as are humidity variations of ±5%. Additionally, air movement in each lab space needs to be properly directed and of sufficient volume to achieve required ventilation rates and provide makeup air for fume hoods without negatively impacting the research program. This problem is compounded in clean rooms due to the airflow rates needed to maintain cleanliness standards.

The CFN will meet the temperature, humidity and airflow requirements by combining state-of-the-art direct digital controls, reheat systems, low airflow fume hoods, and low velocity diffuser systems to meet the specific requirements of each lab space and/or instrument.

A commissioning program will be established as part of the design process. The design team shall provide a commissioning plan and check out list as part of the project specifications. The plan shall require verification that the final installed systems meet the design parameters and operate as intended by the designer. An independent commissioning contract shall be awarded by BNL to verify the design parameters have been achieved. The commissioning contractor shall test and verify that specified mechanical, electrical and control systems meet specified performance. The installing contractor shall assist the commissioning contractor in the performance of test and check out. The design team shall assist the commissioning contractor to resolve any non conformance issues.

The special design features of the CFN related to sustainable design and LEED certification will be developed in detail during Title I design. The design team will include LEED certified architects and engineers. The project objective is to obtain the highest LEED certification feasible, up to “Silver,” within the constraints of the project budget and research mission performance requirements. Sustainable design elements in the project will include selection of sustainable materials, energy efficient products, exhaust heat recovery systems, provision for future use of photovoltaics, use of sun shielding and low E-glass, stormwater reuse for landscape irrigation, passive solar heating and maximum use of day lighting in day-time work spaces. Additional opportunities to incorporate Green Building criteria will be considered during the Title I and Title II design.

D. LIST OF DRAWINGS

SK-9899-R1 – BNL CFN - Conceptual Rendering

SK-9899-L1 – BNL CFN - Location Plan

SK-9899-S1 – BNL CFN - Site Plan

SK-9899-A1 – BNL CFN - First Floor Plan

SK-9899-A2 – BNL CFN - Second Floor Plan

SK-9899-A3 – BNL CFN - Penthouse Floor Plan

SK-9899-C1 – BNL CFN - Demolition Site Plan – Water & Steam

SK-9899-C2 – BNL CFN - Demolition Site Plan –Sanitary

SK-9899-C3 – BNL CFN - Demolition Site Plan – Storm System

SK-9899-C4 – BNL CFN - Site Plan – Utility Services

SK-9899-C5 – BNL CFN - Site Plan – Sanitary Piping

SK-9899-C6 – BNL CFN - Site Plan – Storm Piping

SK-9899-M1 – BNL CFN - HVAC-First Floor Plan

SK-9899-M2 – BNL CFN - HVAC-Second Floor Plan

SK-9899-M3 – BNL CFN - HVAC-Penthouse Floor Plan

SK-9899-FP1 – BNL CFN - Fire Protection First Floor Plan

SK-9899-FP2 – BNL CFN - Fire Protection Second Floor Plan

SK-9899-FP3 – BNL CFN - Fire Protection Penthouse Floor Plan

SK-9899-E1 – BNL CFN - Electrical – Site Plan

SK-9899-E2 – BNL CFN - Electrical - First Floor Plan

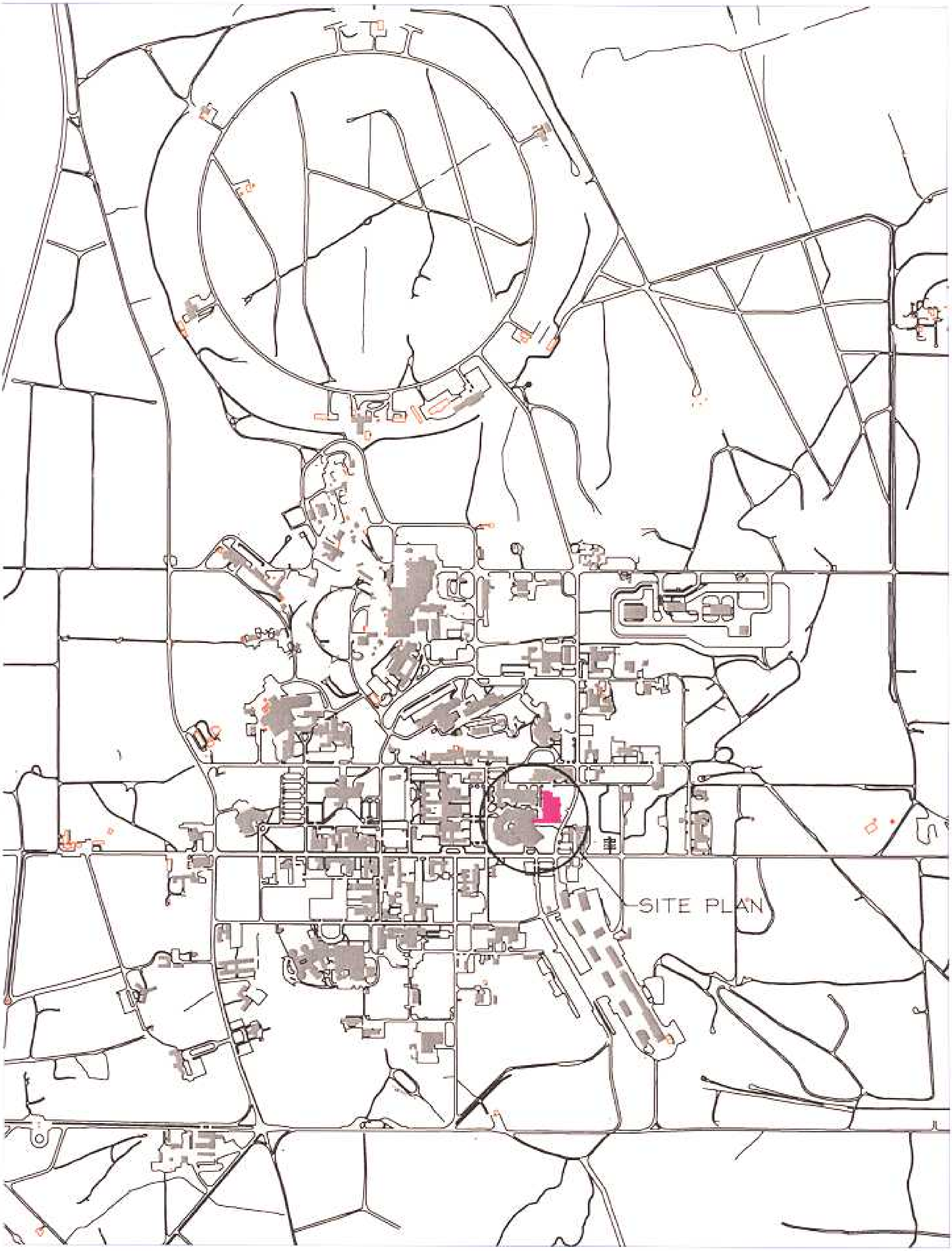
SK-9899-E3 – BNL CFN - Electrical – Second Floor Plan

SK-9899-E4 – BNL CFN - Electrical – Penthouse Floor Plan

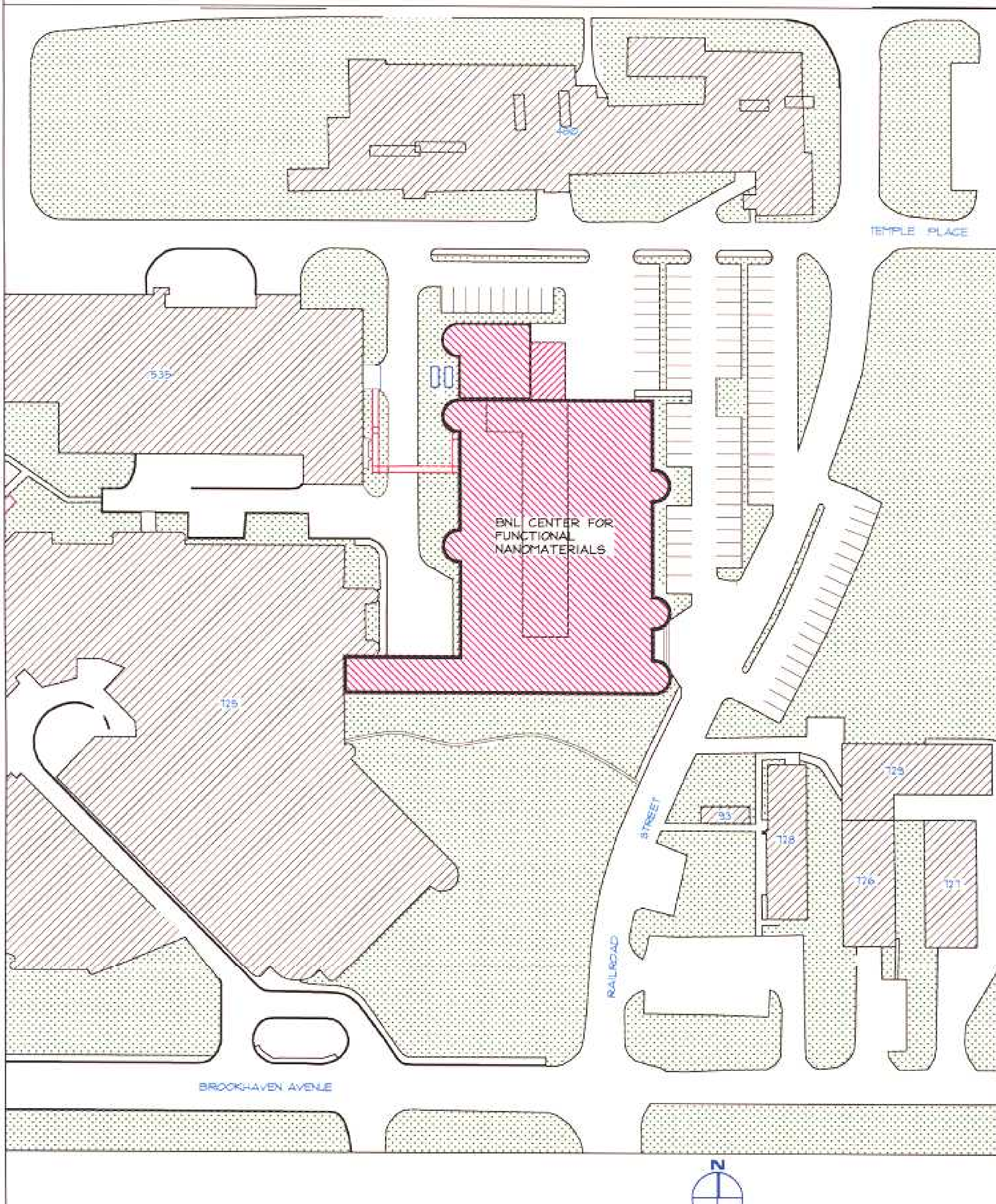
SK-9899-E5 – BNL CFN - Electrical - One-Line-Diagram

SK-9899-E6 – BNL CFN - Electrical - Riser Diagram

SK- 9899 R1 Conceptual Rendering



BROOKHAVEN NATIONAL LABORATORY	BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 1.3.1
PLANT ENGINEERING E & CS DIVISION UPTON, NEW YORK 11973	LOCATION PLAN	SK-9899-L1



BROOKHAVEN
NATIONAL LABORATORY

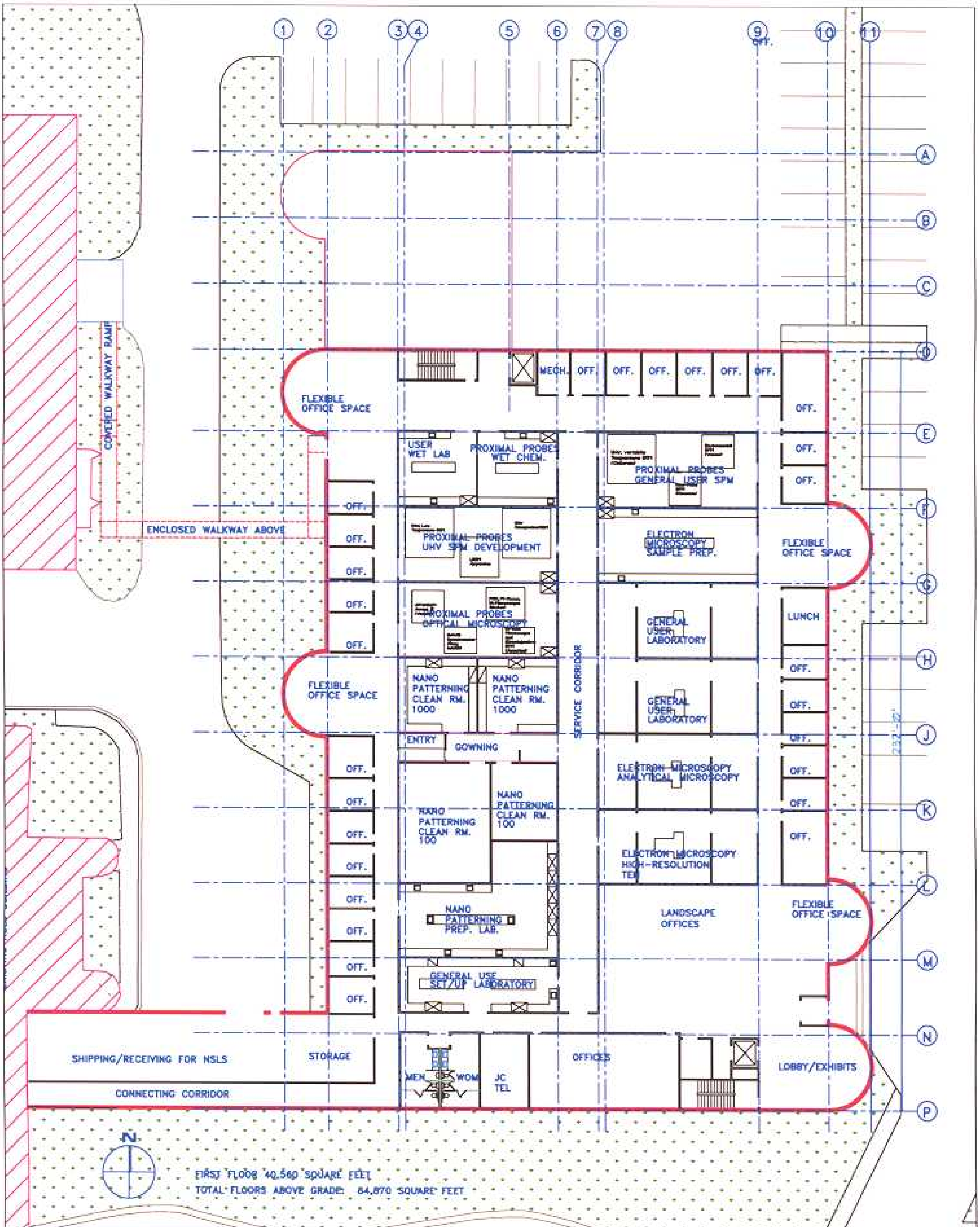
PLANT ENGINEERING DIVISION
UPTON, NEW YORK 11973

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

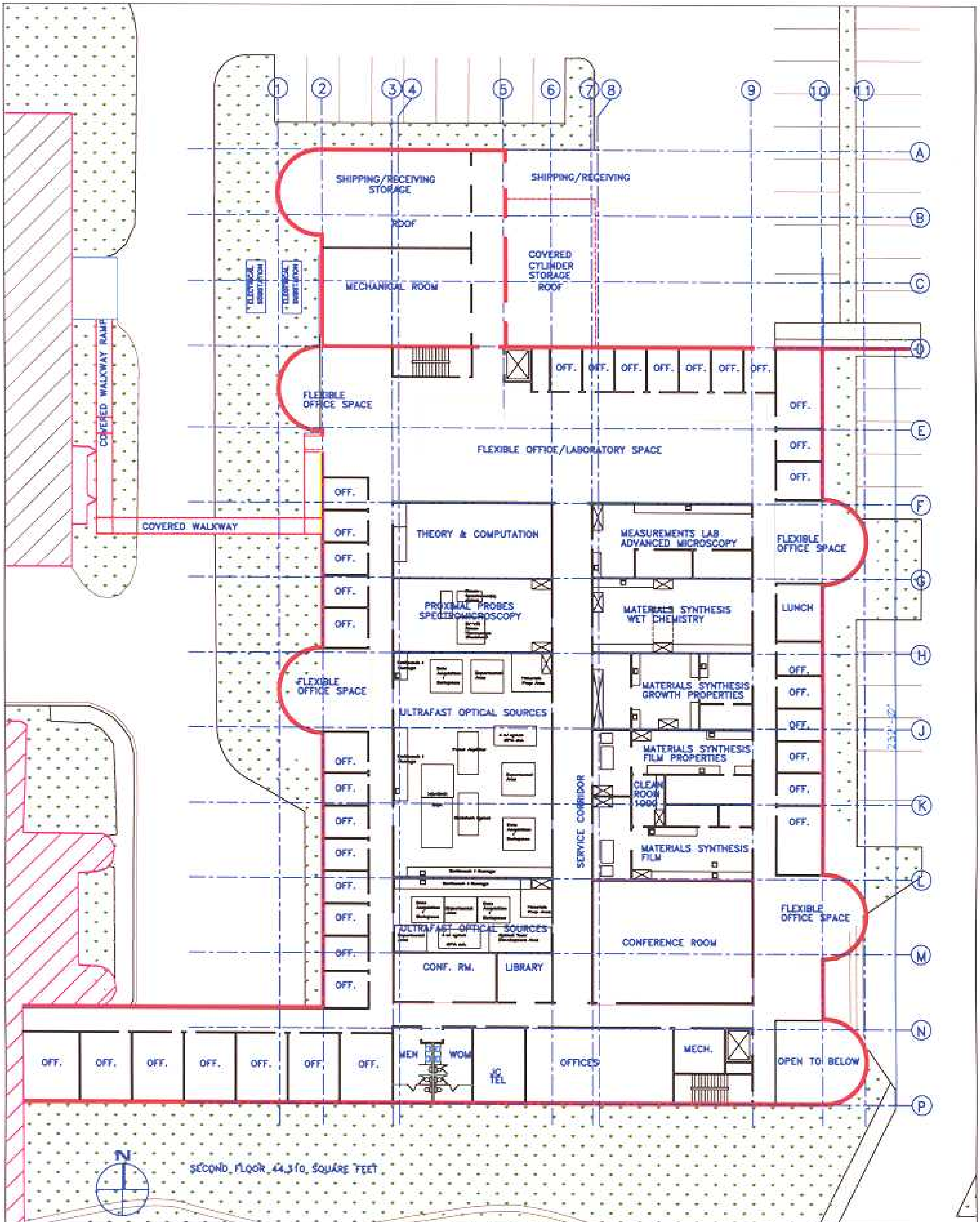
WBS 1.3.1

SITE PLAN

SK-9899-S1



BROOKHAVEN NATIONAL LABORATORY	BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 1.3.2
PLANT ENGINEERING DIVISION UPTON, NEW YORK 11973	FIRST FLOOR PLAN	SK-9899-A1



BROOKHAVEN NATIONAL LABORATORY

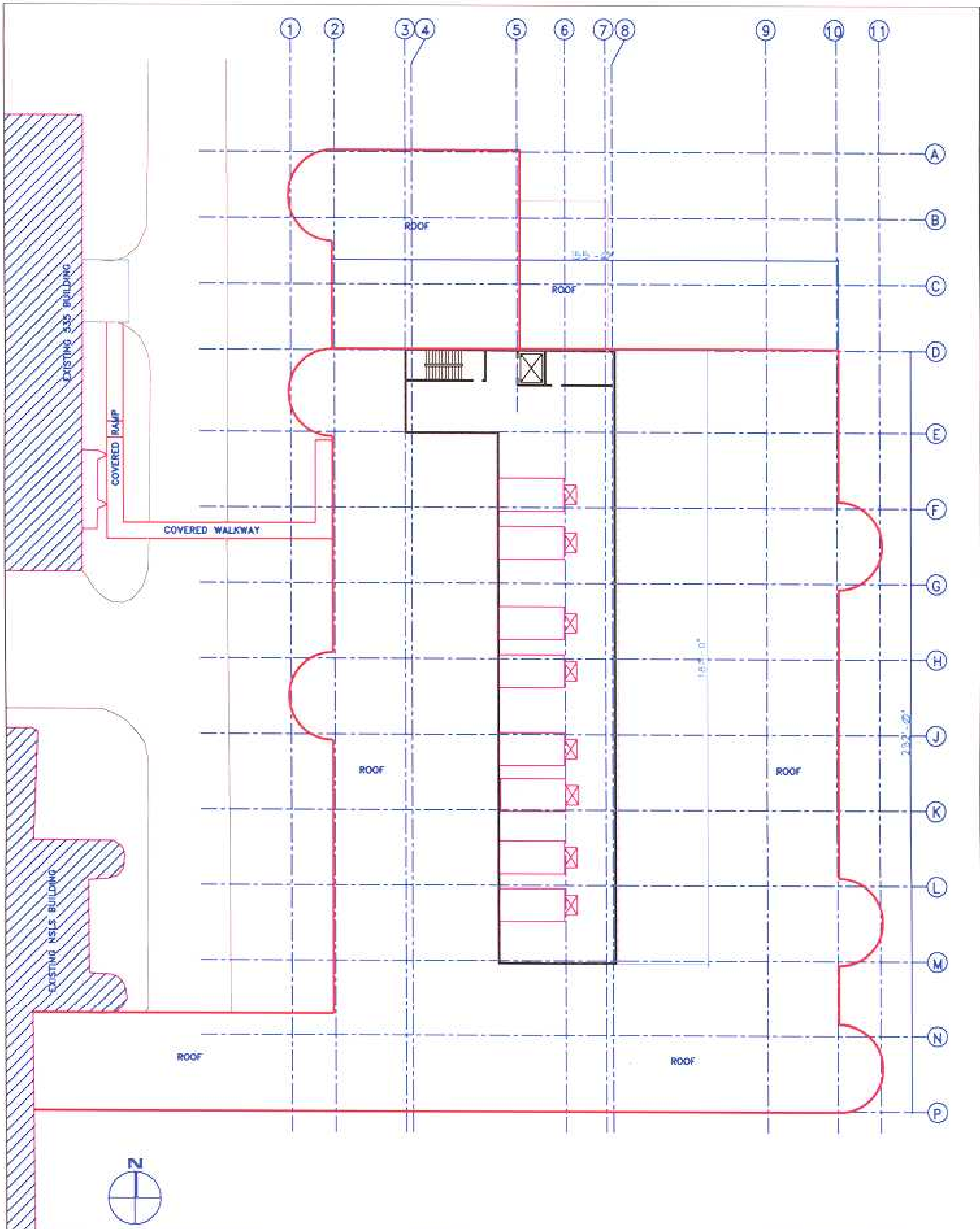
PLANT ENGINEERING DIVISION
UPTON, NEW YORK 11973

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

WBS 1.3.2

SECOND FLOOR PLAN

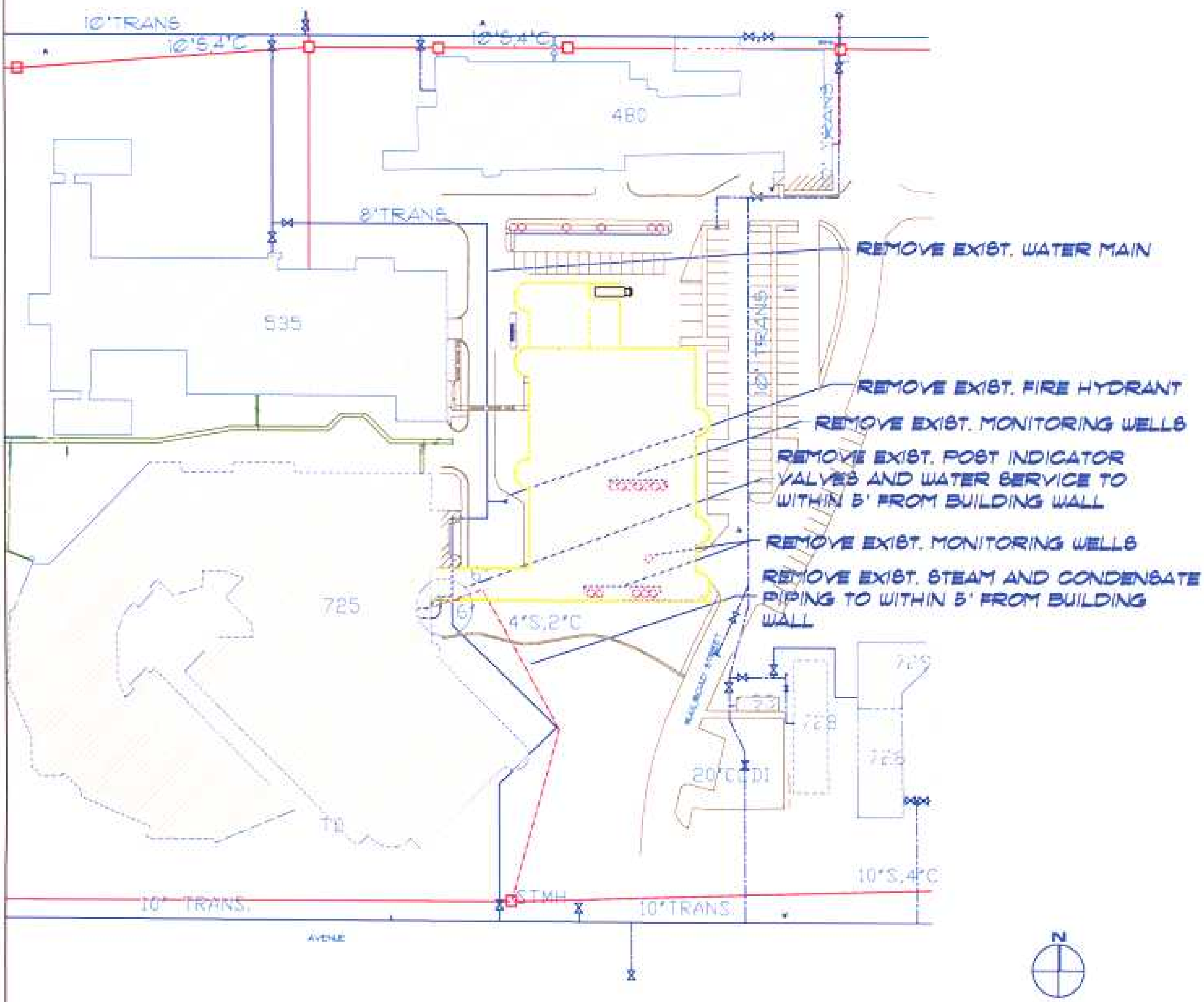
SK-9899-A2



BROOKHAVEN
NATIONAL LABORATORY

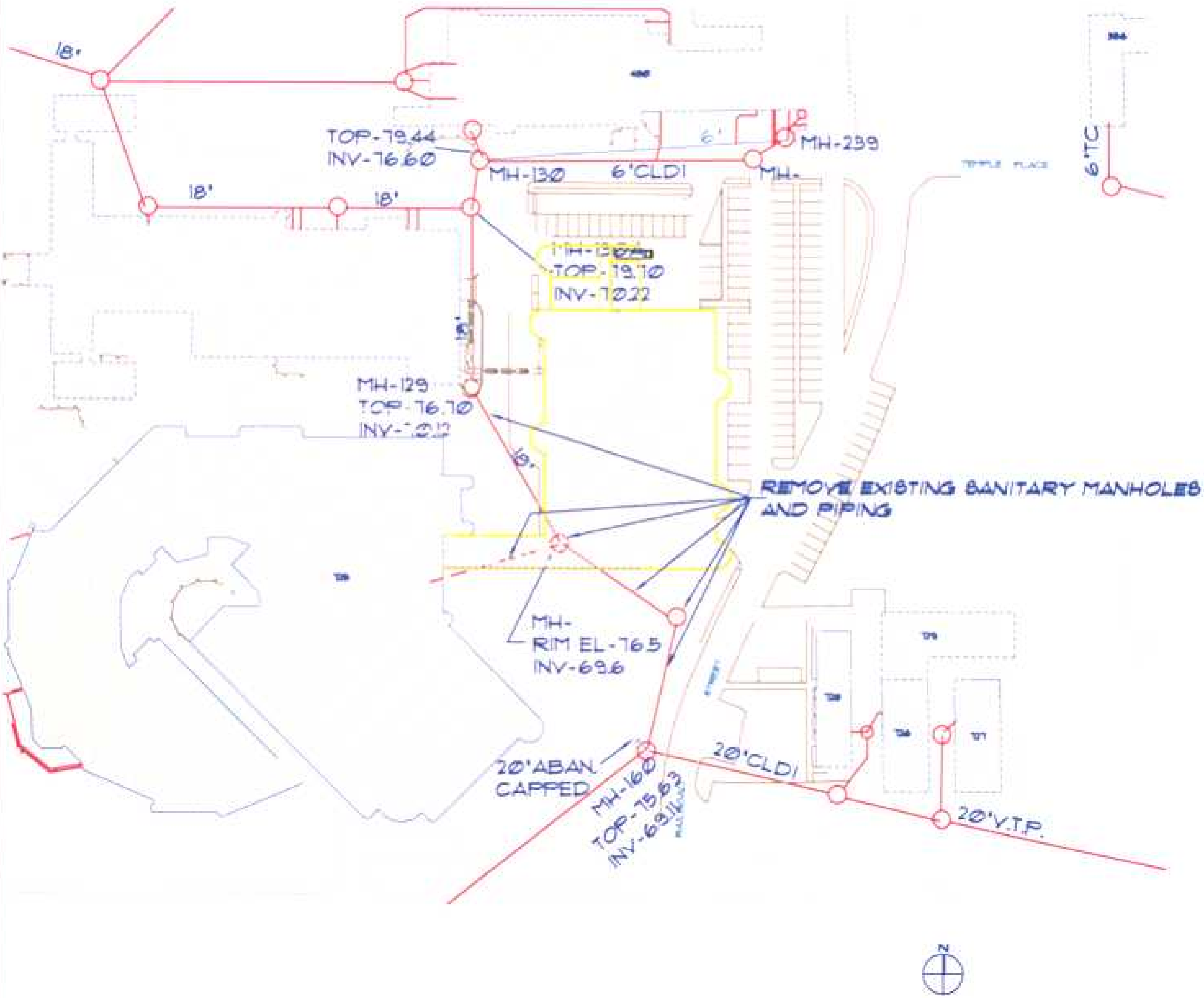
PLANT ENGINEERING DIVISION
UPTON, NEW YORK

BNL CENTER FOR FUNCTIONAL NANOMATERIALS		WBS 1.3.2
PENTHOUSE FLOOR PLAN		SK-9899-A3



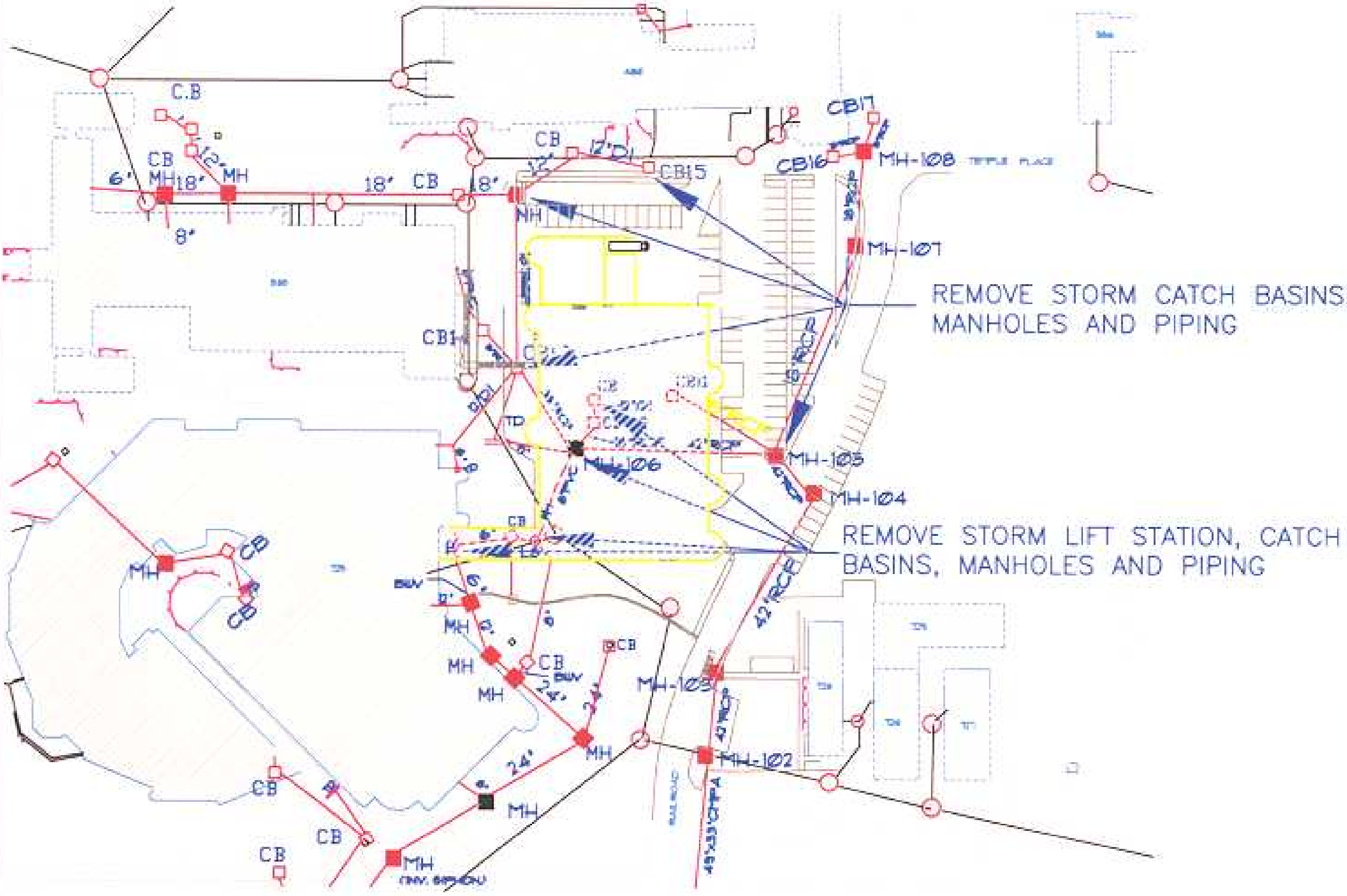
STEAM, CONDENSATE, POTABLE WATER AND MONITORING WELL DEMOLITION PLAN

BROOKHAVEN NATIONAL LABORATORY PLANT ENGINEERING DIVISION UPTON, NEW YORK	BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 1.3.3
	DEMOLITION SITE PLAN - WATER & STEAM	SK-9899-C1



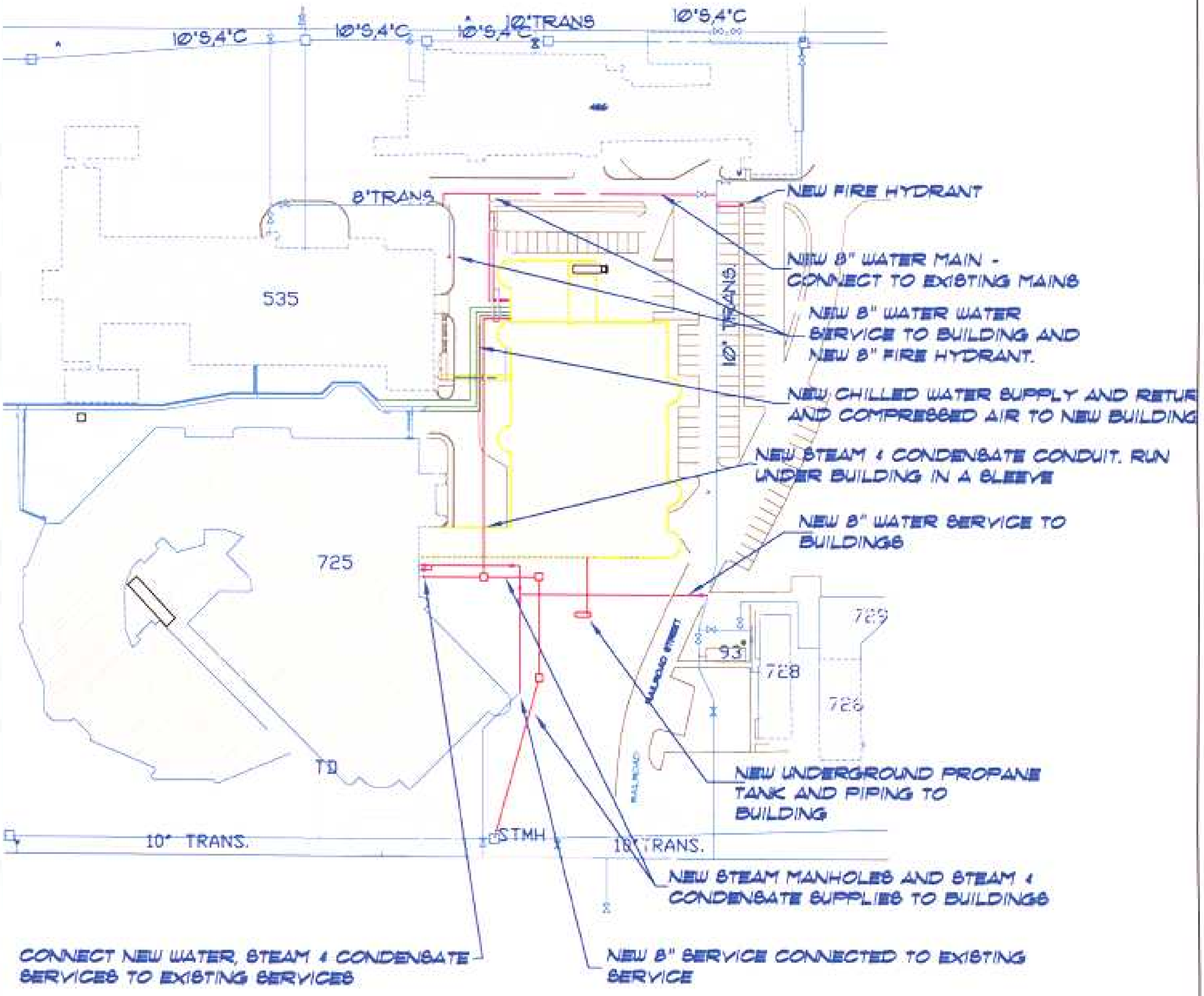
SANITARY SYSTEM DEMOLITION PLAN

BROOKHAVEN NATIONAL LABORATORY PLANT ENGINEERING DIVISION UPTON, NEW YORK	BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 1.3.3
	DEMOLITION SITE PLAN - SANITARY	SK-9899-C2



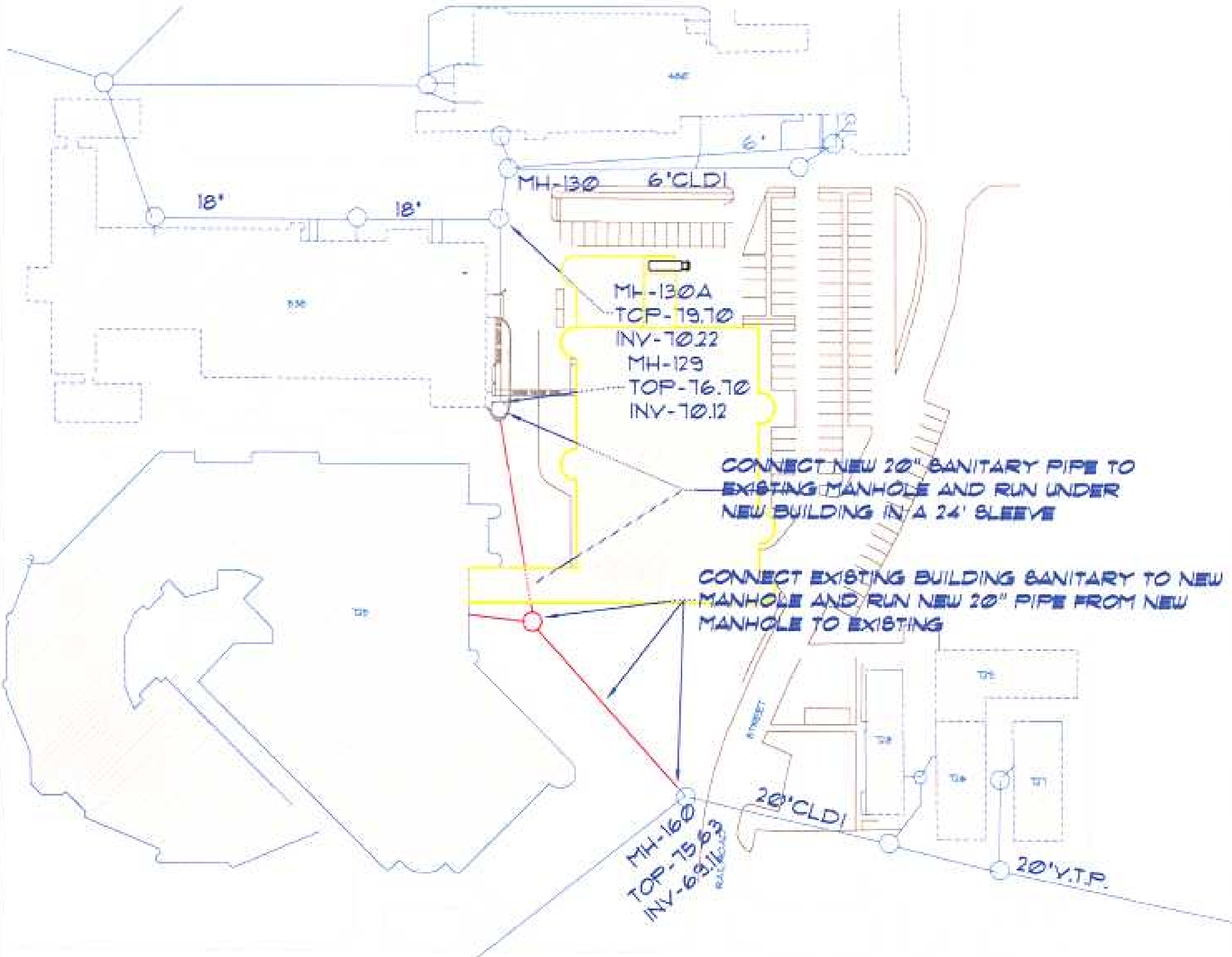
STORM SYSTEM DEMOLITION PLAN

BROOKHAVEN NATIONAL LABORATORY PLANT ENGINEERING DIVISION UPTON, NEW YORK 11973	BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 1.3.3
	DEMOLITION SITE PLAN - STORM SYSTEM	SK-9899-C3



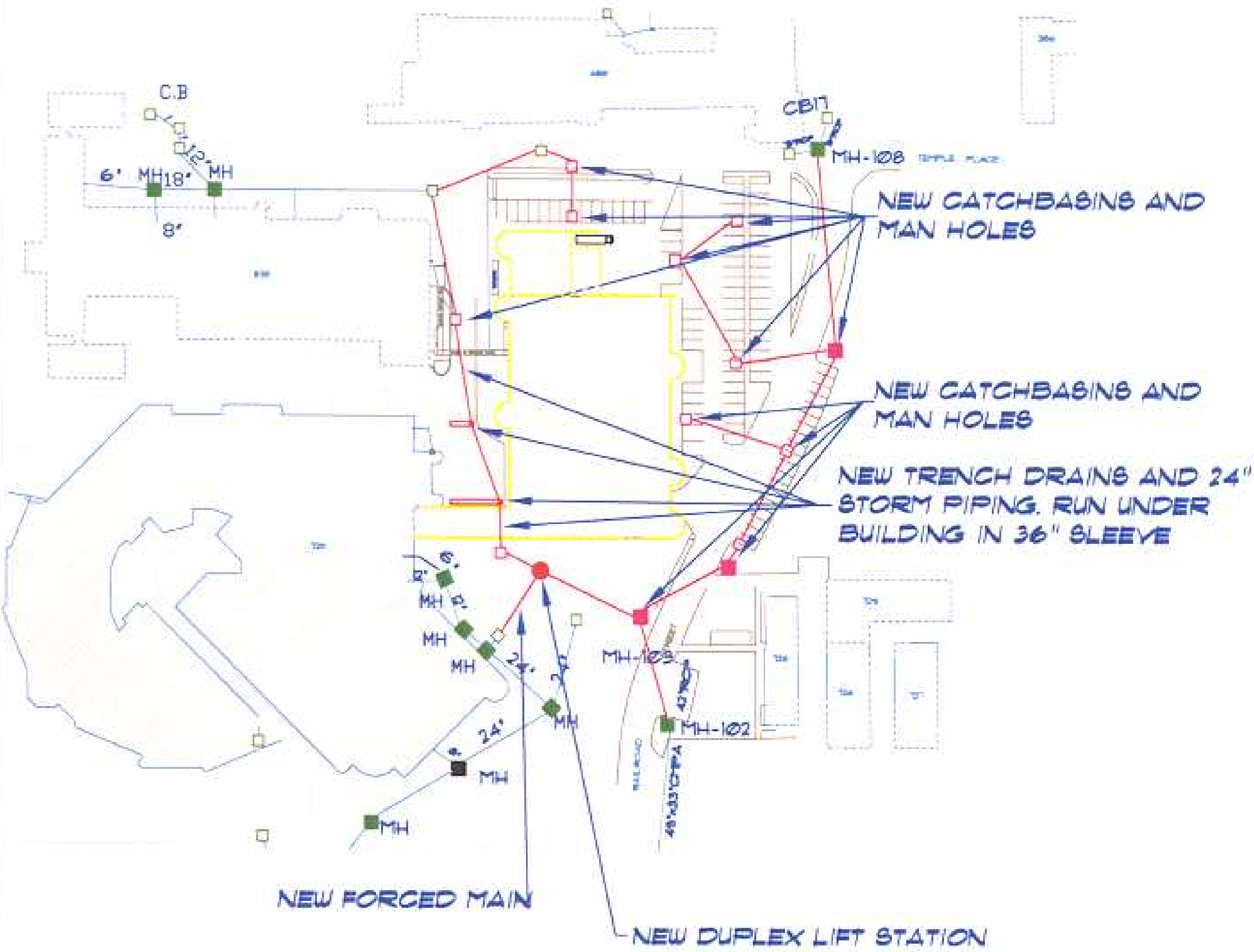
NEW STEAM, PROPANE, CONDENSATE, CHILLED WATER AND POTABLE WATER TO BUILDING

BROOKHAVEN NATIONAL LABORATORY PLANT ENGINEERING DIVISION UPTON, NEW YORK 11973	BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 1.3.3
	SITE PLAN - UTILITY SERVICES	SK-9899-C4



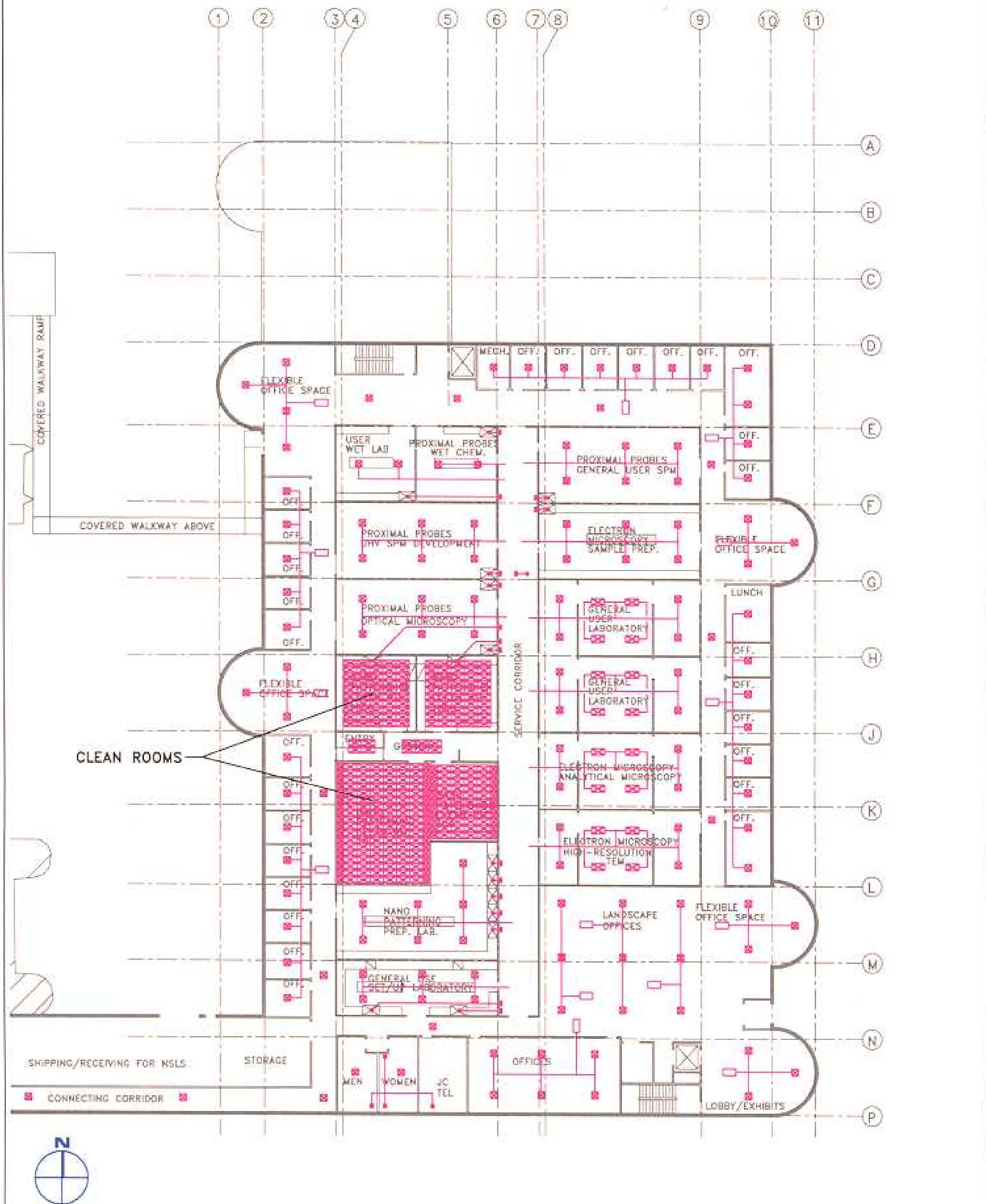
SITE PLAN - SANITARY PIPING

BROOKHAVEN NATIONAL LABORATORY PLANT ENGINEERING DIVISION UPTON, NEW YORK	BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 1.3.3
	SITE PLAN - SANITARY PIPING	SK-9899-C5



SITE PLAN - STORM PIPING

BROOKHAVEN NATIONAL LABORATORY PLANT ENGINEERING DIVISION UPTON, NEW YORK 11973	BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 1.3.3
	SITE PLAN - STORM PIPING	SK-9299-C6



BROOKHAVEN NATIONAL LABORATORY

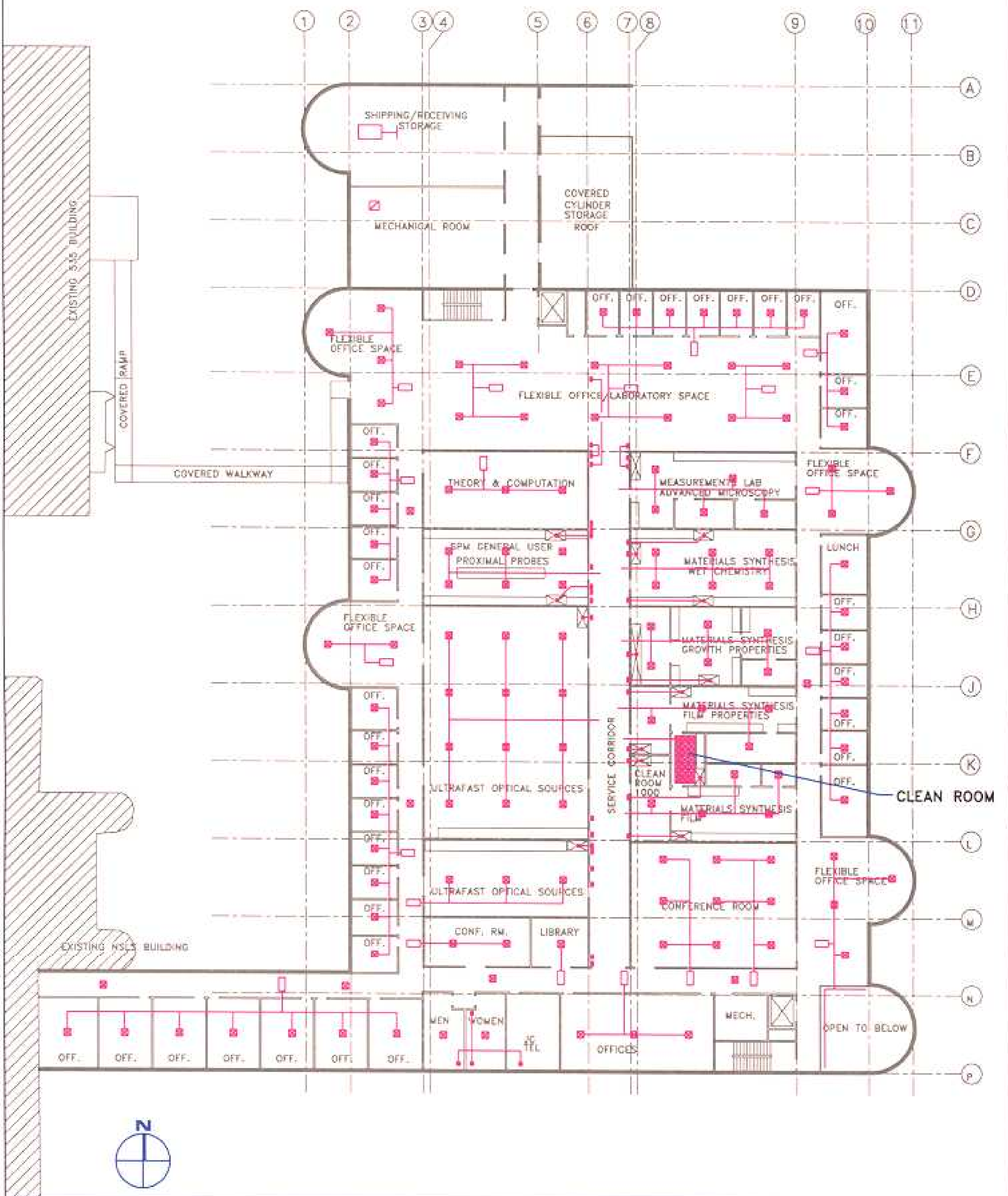
PLANT ENGINEERING DIVISION
UPTON, NEW YORK 11973

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

HVAC FIRST FLOOR PLAN

WBS 1.3.2

SK-9899-M1



BROOKHAVEN NATIONAL LABORATORY

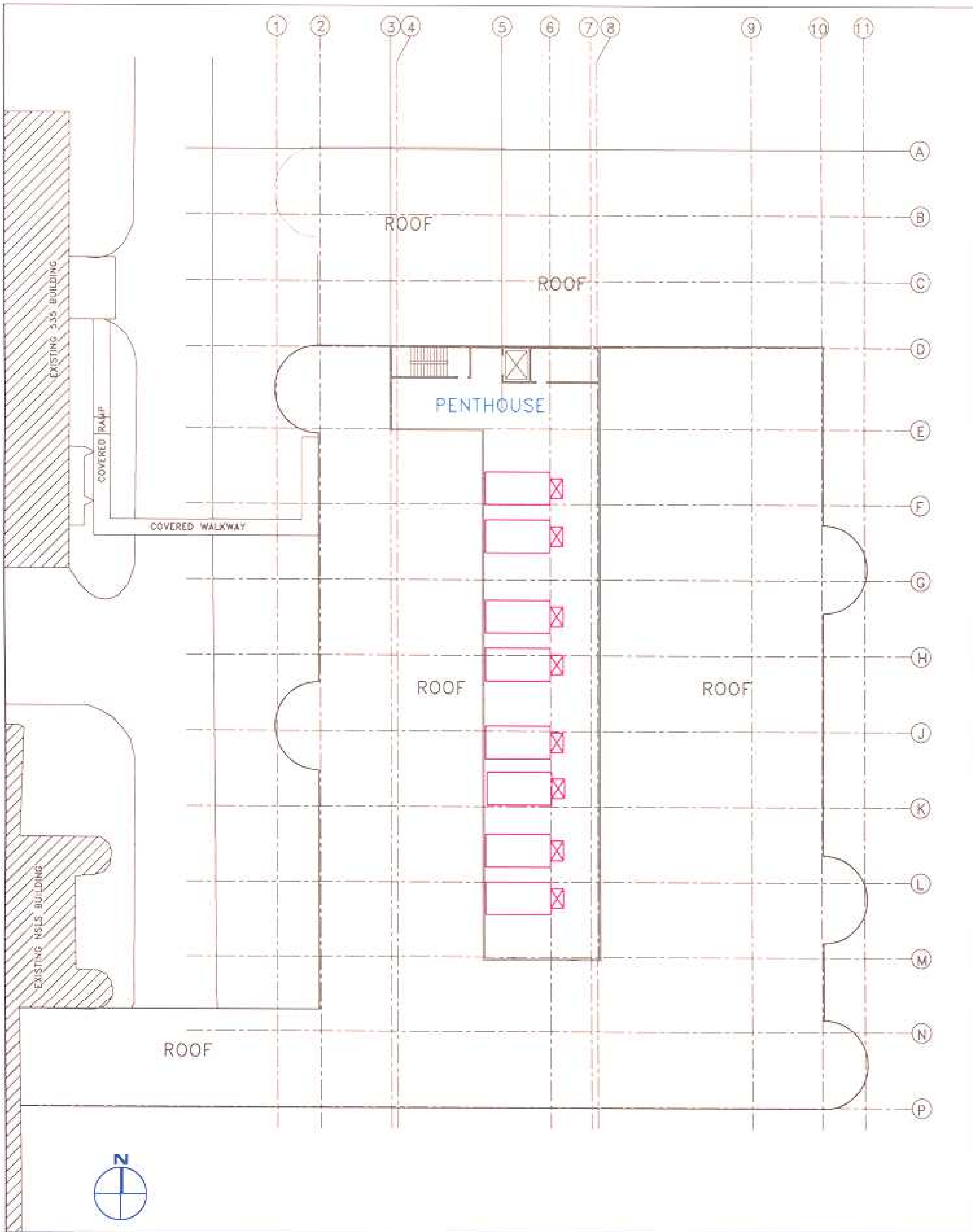
PLANT ENGINEERING DIVISION
UPTON, NEW YORK 11973

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

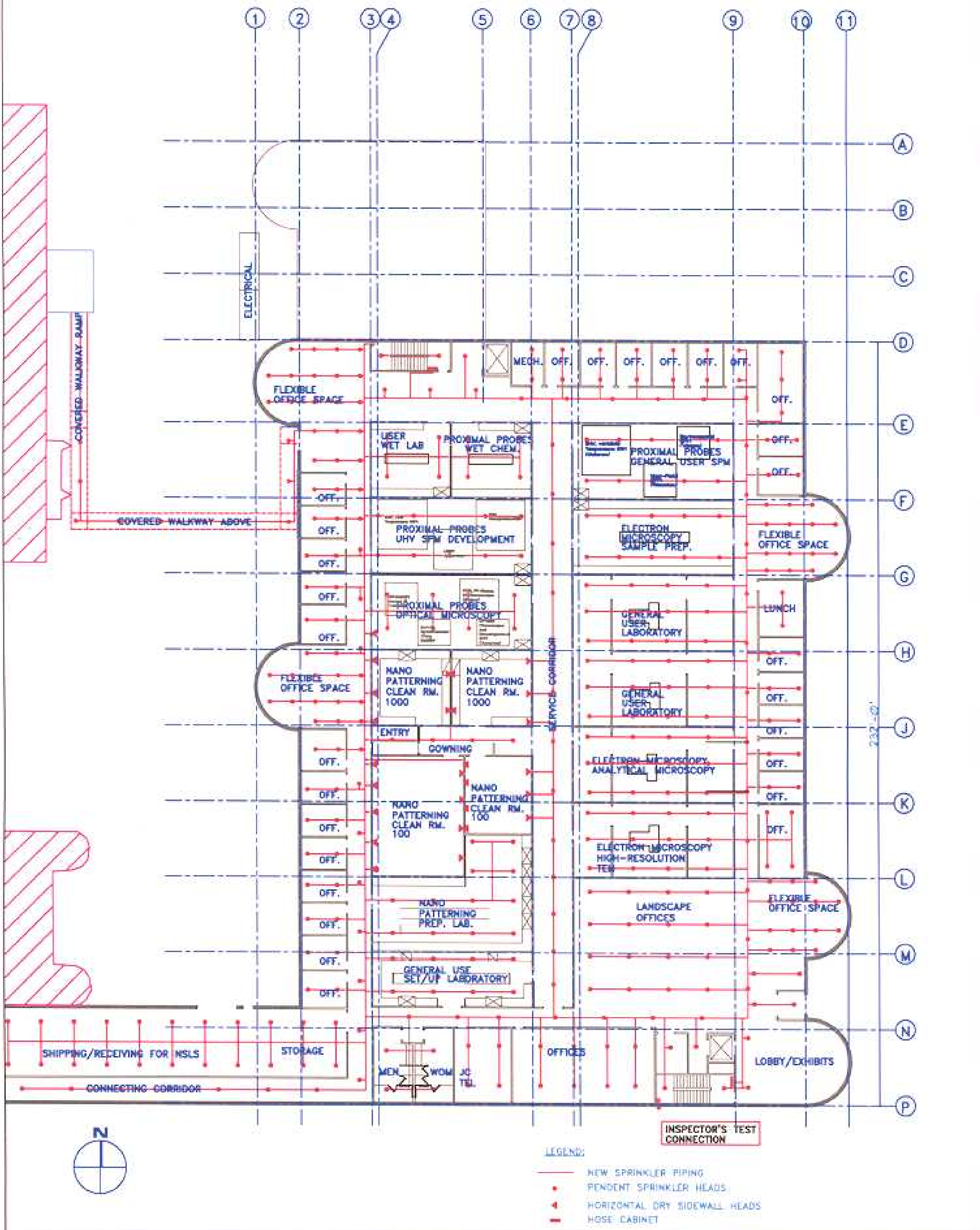
WBS 1.3.2

HVAC SECOND FLOOR PLAN

SK-9893-M2



BROOKHAVEN NATIONAL LABORATORY PLANT ENGINEERING DIVISION UPTON, NEW YORK 11973	BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 1.3.2
	HVAC PENTHOUSE FLOOR PLAN	SK-9899-M3



BROOKHAVEN NATIONAL LABORATORY

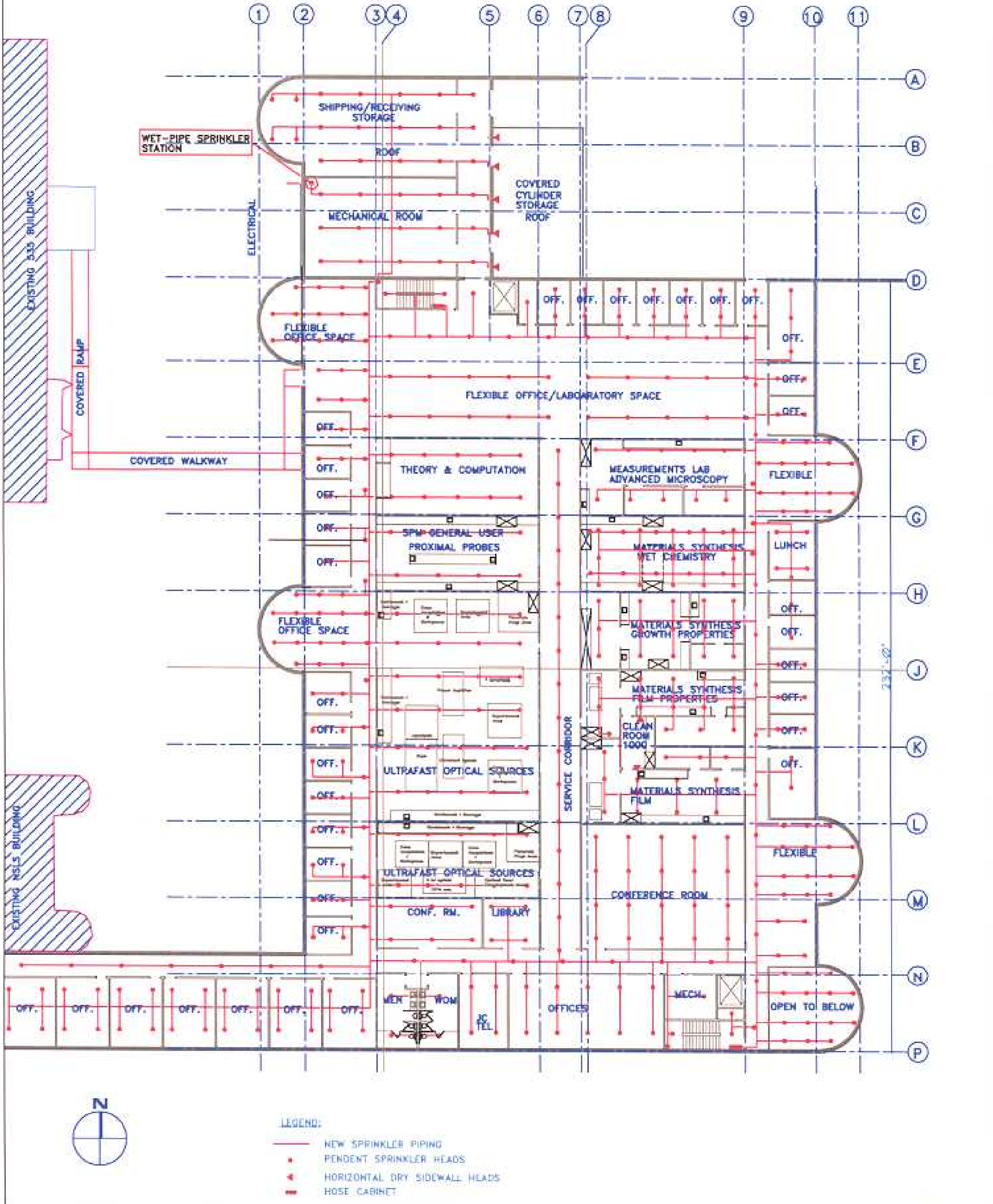
PLANT ENGINEERING DIVISION
UPTON, NEW YORK 11973

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

WBS 1.3.2

FIRE PROTECTION FIRST FLOOR PLAN

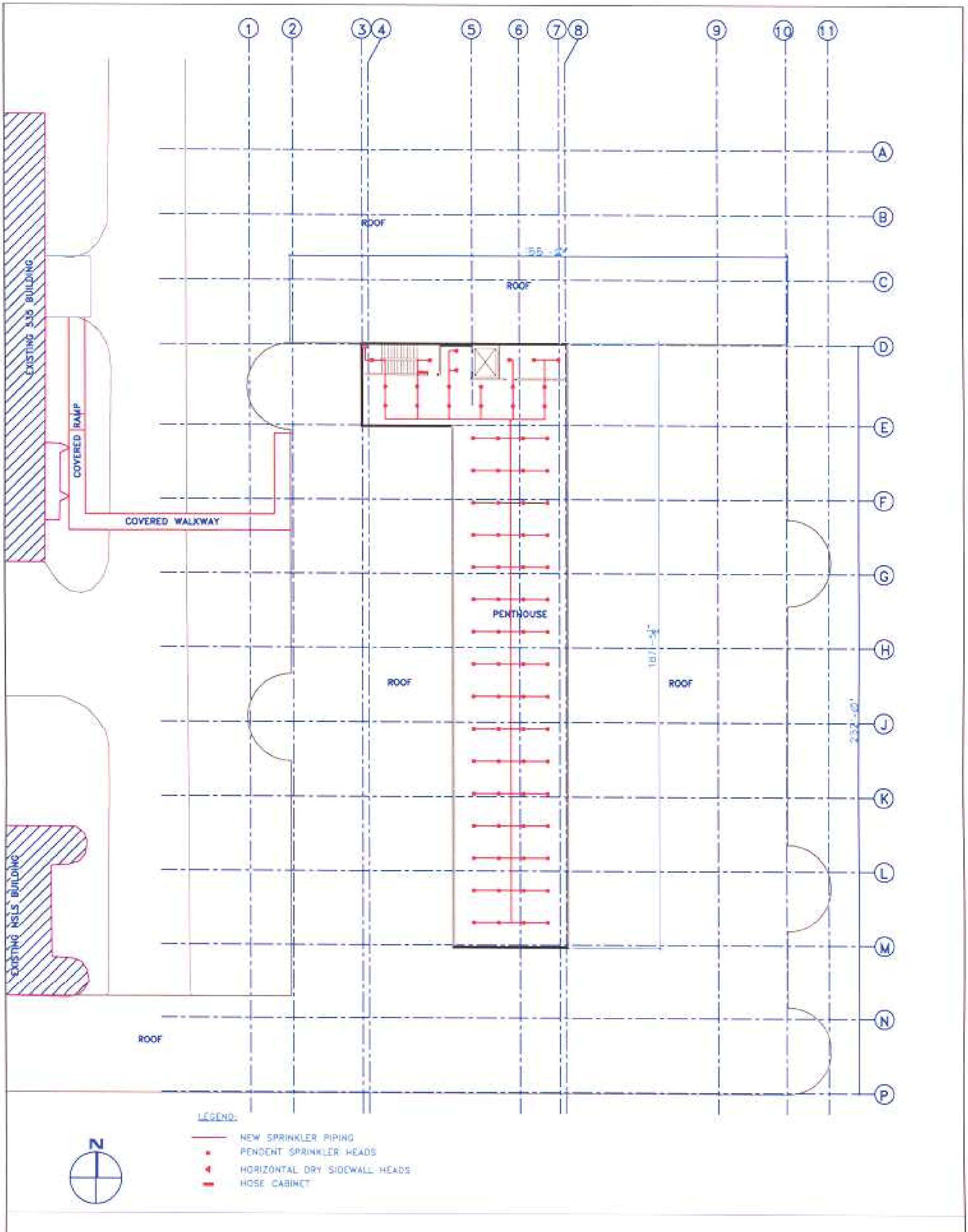
SK-9899-FP1



BROOKHAVEN NATIONAL LABORATORY

PLANT ENGINEERING DIVISION
UPTON, NEW YORK 11973

BNL CENTER FOR FUNCTIONAL NANOMATERIALS		WBS 1.3.2
FIRE PROTECTION SECOND FLOOR PLAN		SK-9899-FP2



BROOKHAVEN NATIONAL LABORATORY

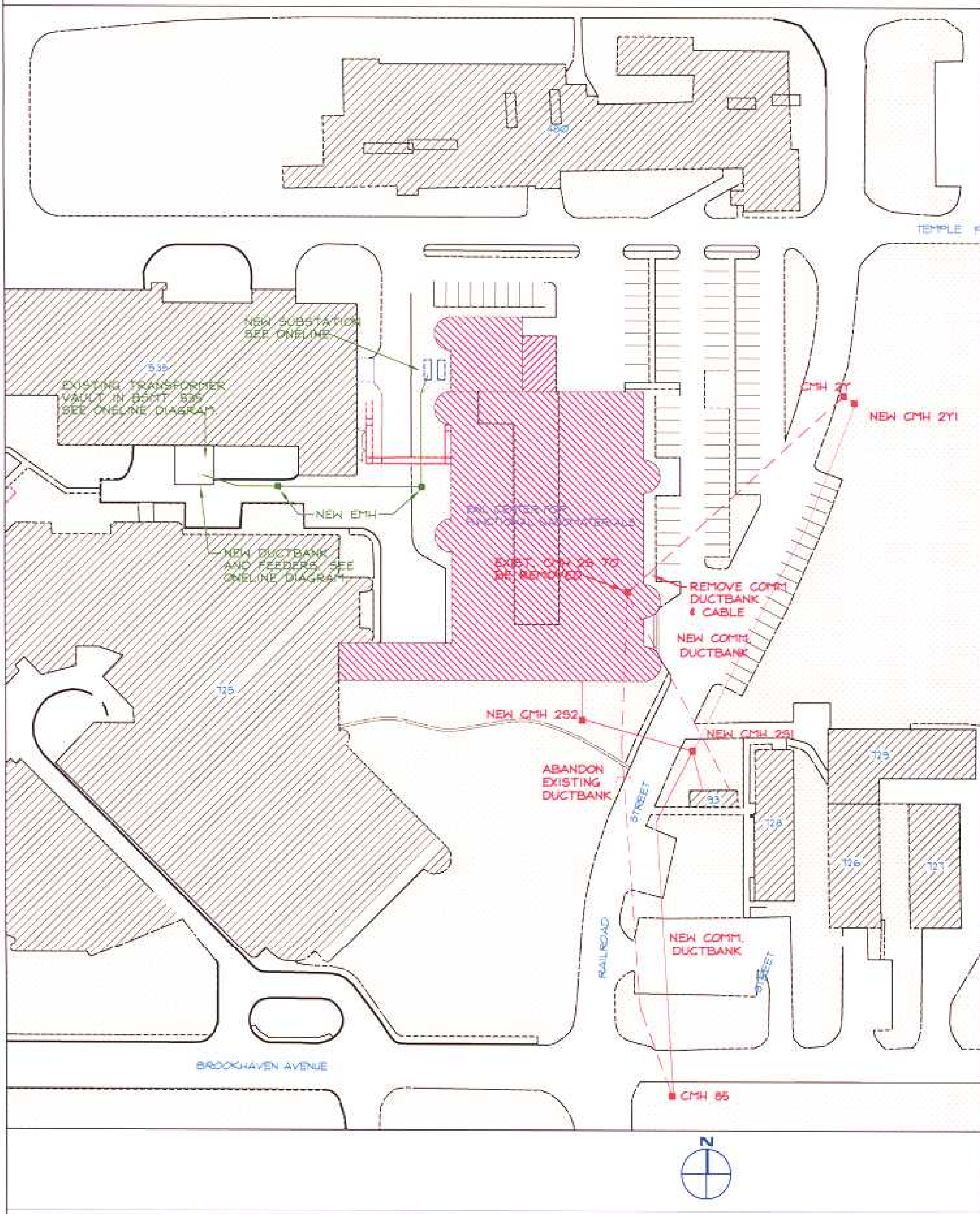
PLANT ENGINEERING DIVISION
UPTON, NEW YORK 11973

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

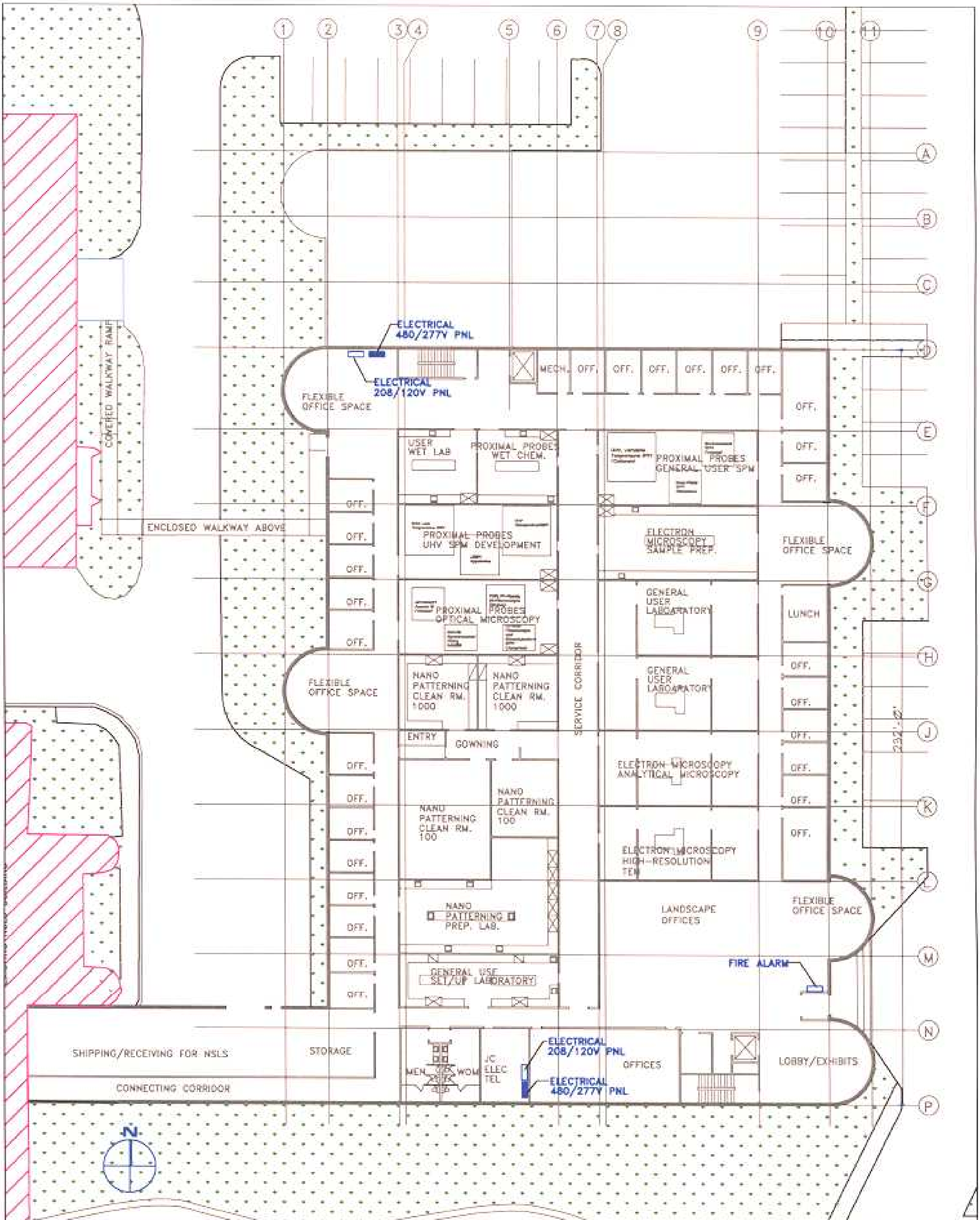
WBS 1.3.2

FIRE PROTECTION PENTHOUSE FLOOR PLAN

SK-9839-FP3



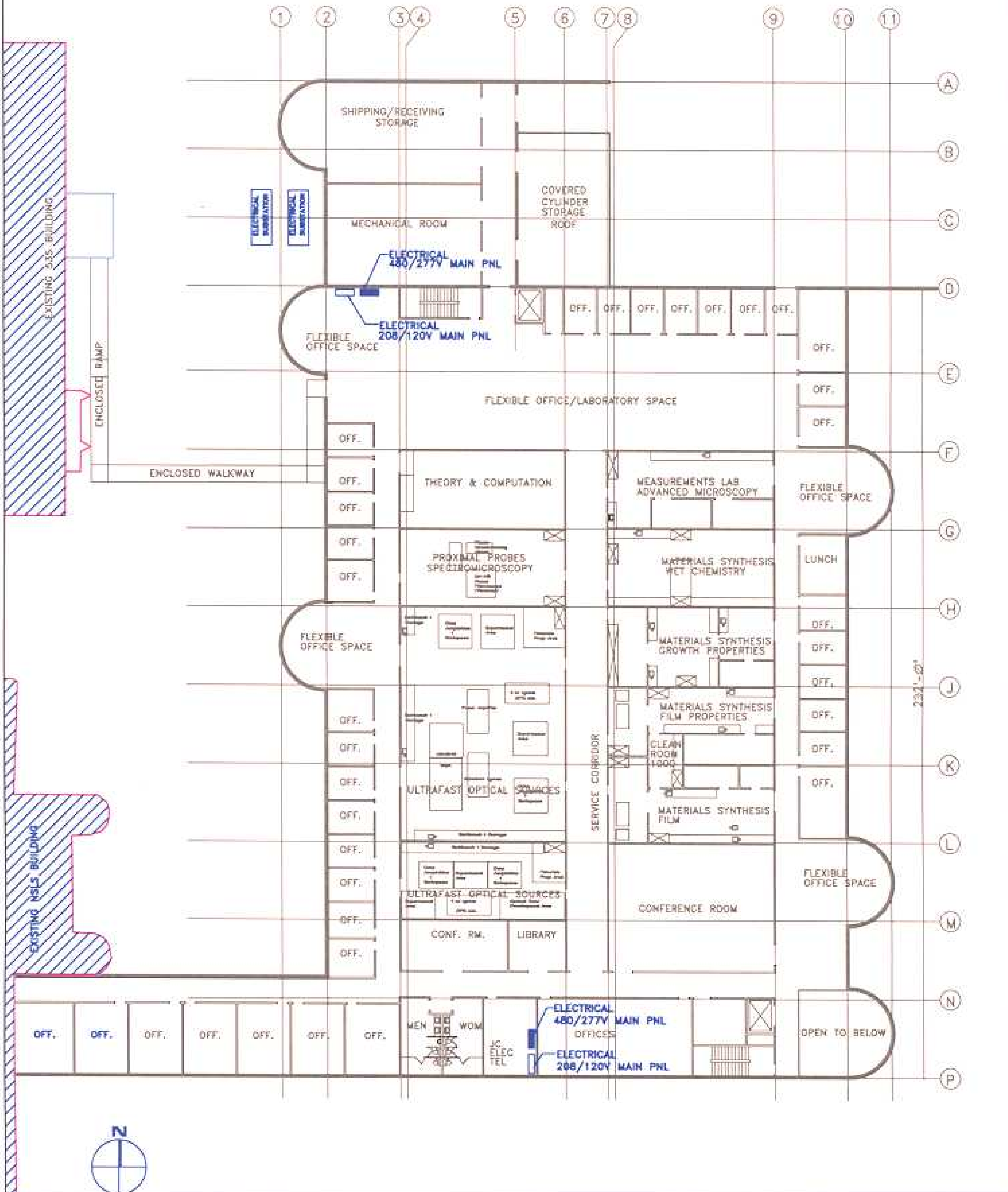
BROOKHAVEN NATIONAL LABORATORY PLANT ENGINEERING DIVISION UPTON, NEW YORK 11973	BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 1.3.1
	ELECTRICAL SITE PLAN	SK-9899-E1



BROOKHAVEN NATIONAL LABORATORY

PLANT ENGINEERING DIVISION
UPTON, NEW YORK 11973

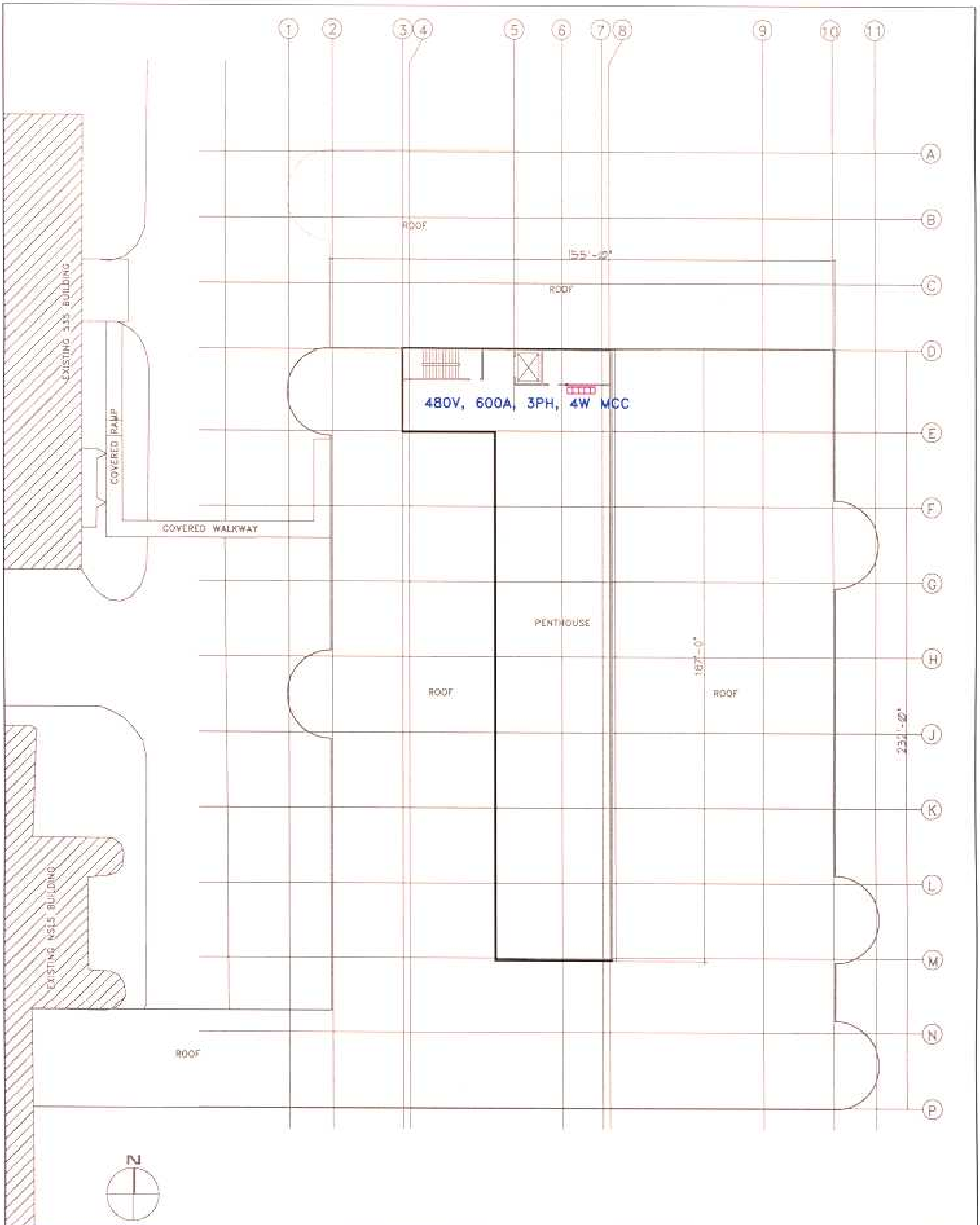
BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 1.3.2
ELECTRICAL - FIRST FLOOR PLAN	SK-9899-E2



BROOKHAVEN NATIONAL LABORATORY

PLANT ENGINEERING DIVISION
UPTON, NEW YORK 11973

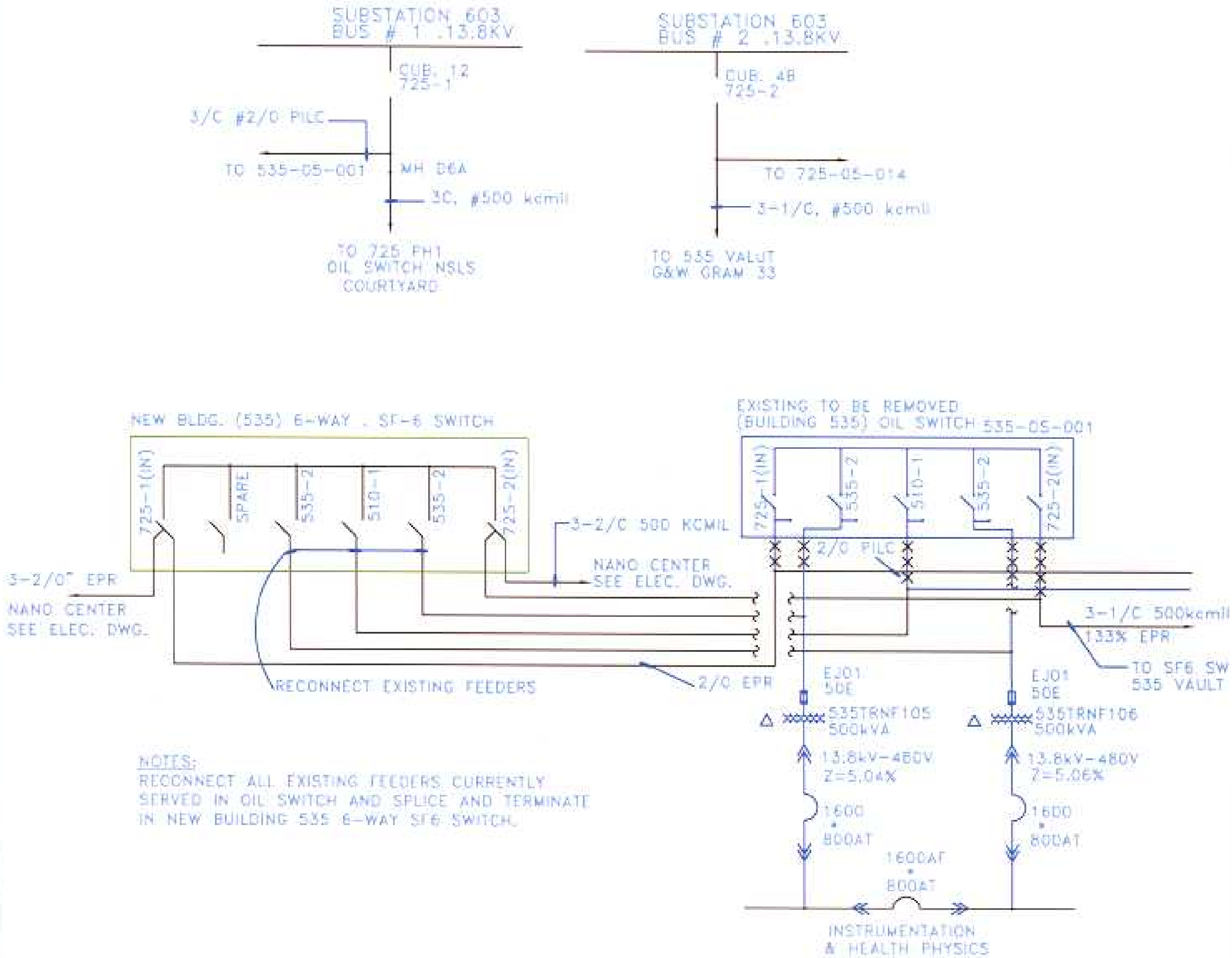
BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 1.3.2
ELECTRICAL-SECOND FLOOR PLAN	SK-9899-E3



BROOKHAVEN NATIONAL LABORATORY

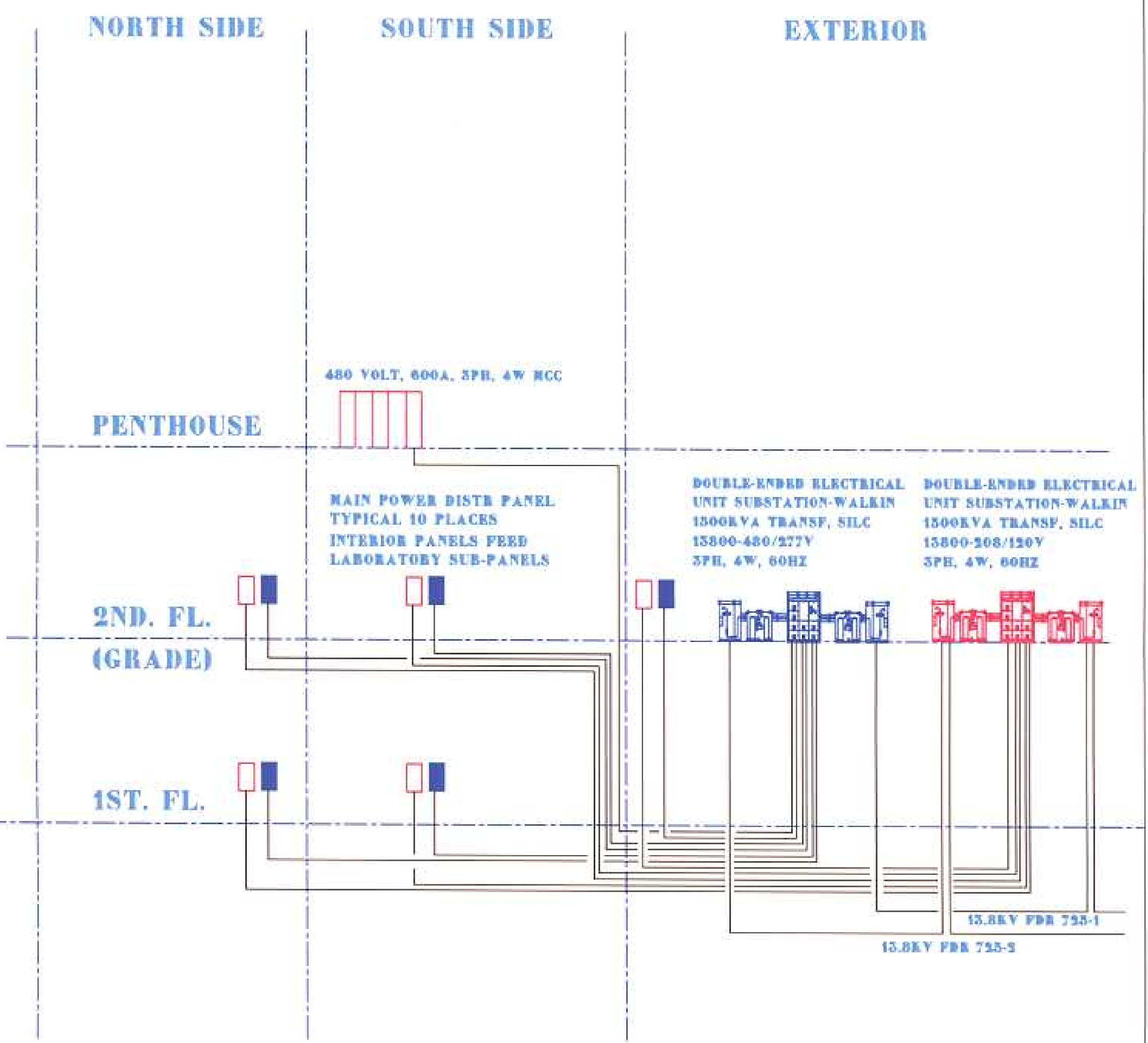
PLANT ENGINEERING DIVISION
UPTON, NEW YORK 11973

BROOKHAVEN NATIONAL LABORATORY	BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 1.3.2
	ELECTRICAL - PENTHOUSE FLOOR PLAN	SK-9899-E4



NOTES:
RECONNECT ALL EXISTING FEEDERS CURRENTLY SERVED IN OIL SWITCH AND SPLICE AND TERMINATE IN NEW BUILDING 535 6-WAY SF6 SWITCH.

BROOKHAVEN NATIONAL LABORATORY PLANT ENGINEERING DIVISION UPTON, NEW YORK 11973	BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 13.2
	ELECTRICAL - ONE LINE DIAGRAM	SK-9899-E5



BROOKHAVEN NATIONAL LABORATORY	BNL CENTER FOR FUNCTIONAL NANOMATERIALS	WBS 1.3.2
PLANT ENGINEERING DIVISION UPTON, NEW YORK 11973	ELECTRICAL RISER DIAGRAM	SK-9899-E6

PROJECT PERFORMANCE

4

SECTION 4. PROJECT PERFORMANCE

A. GENERAL

The CFN project will be managed in accordance with the requirements of DOE Order 413.3, Program and Project Management for the Acquisition of Capital Assets. A Preliminary Project Execution Plan (PPEP) has been prepared and is provided in Appendix A. The approved PEP will indicate the scope, cost, and schedule; change control methods; methods of execution, responsible parties, lines of authority; quality assurance methods; and review and reporting requirements needed to comply with DOE Order 413.3 and successfully execute this project. BNL has a proven track record of successfully managing projects comparable in scope, cost and complexity to the CFN and will apply that experience to this project.

B. PRELIMINARY PROJECT EXECUTION PLAN

BNL has extensive knowledge of the technical requirements and feasibility of this project and recent experience in managing, monitoring, and performing the type of work required for the BNL Center for Functional Nanomaterials project. The Preliminary Project Execution Plan (PPEP) is contained in the Appendix A.

The scope of the CFN Project has been fully defined as indicated in Section 4, D. Work Breakdown Structure Details. An activity based schedule has been prepared as indicated in Section 4, E. Project Schedule, which identifies activity durations, and milestones. The project cost estimate, provided in Section 7, has been prepared utilizing a bottom-up approach with nationally recognized estimating methods and actual vendor quotations. Cost estimates include application of all appropriate escalation and BNL indirect burdens.

Risks and uncertainties that could impact the project cost have been evaluated for each WBS level-three activity and converted to an appropriate level of contingency funds for the project. A risk management strategy has been developed, provided in Appendix E, that indicates the decision process and accountabilities needed to effectively address changing conditions and uncertainties as the project progresses.

An Integrated Project Team (IPT) has been established as indicated on Figure 4-1 to execute this project. The IPT members have been selected based on the project scope requirements and their expertise relevant to the CFN and are available to execute the project based on the proposed schedule. Clear lines of authority and responsibility to manage and execute the project have been established.

The planned method of accomplishment for the CFN Project listed below has been successfully utilized by BNL to complete projects within scope, budget and schedule:

1. Overall project management, quality assurance, technical procurement and construction management of Title III will be performed by Brookhaven National Laboratory. Title III construction observation and inspection will be supplemented by architectural/engineering (A/E) field staff under contract to BNL.

2. Title I (preliminary) and Title II (detail) design will be performed by a competitively selected A/E firm under contract to BNL. Sustainable design will be included as part of their scope of services. BNL will appoint an independent team of BNL and/or A/E staff to conduct the value engineering review during Title I design.

3. Title III construction will be performed by a lump sum, competitively bid construction contract. The Fixed Priced Subcontractor will be selected in accordance with BNL's competitive/evaluated construction contractor procurement process. Specific use of incentive/penalty clauses in contracts will be determined during the Title I and Title II design based on progress to date and development of a detailed contracting plan. The construction will be executed as a single construction procurement with phased funding authority.

4. Specification and procurement of technical equipment will be performed by BNL. Procurement of technical equipment will consist of multiple lump-sum competitively procured contracts. Timing and grouping of technical procurements will be developed during Title I to maximize competitive procurement opportunities consistent with performance requirements,

funding availability and readiness of conventional facilities to receive equipment. Installation of technical equipment by vendor technicians will be included in the equipment contracts where feasible. Commissioning and start-up of the equipment will be performed by BNL technical staff supported by vendor technicians.

C. ACQUISITION PLAN

The acquisition strategy for the CFN project is described in detail in the CFN Acquisition Execution Plan provided in Appendix D. As indicated above, in the Preliminary Project Execution Plan, the CFN will be managed by an Integrated Project Team consisting of BNL and DOE/BAO staff:

1. BNL will perform overall project management and construction management.

2. Title I and II Design will be performed by an A/E firm under contract to BNL. The A/E firm will be competitively selected based on best technical qualifications for this project. The A/E firm will also provide Title III support services for construction inspection, start-up and commissioning.

3. Technical construction will involve procurement of numerous specialized laboratory instruments. Specifications and procurement packages for the instruments will be developed by the BNL technical design staff. Where feasible, instrument packages will be grouped to take advantage of quantity discounting by vendors to enable procurement at the lowest possible price. Installation, start-up and commissioning services will be procured from instrument vendors wherever feasible.

4. Conventional construction will involve construction of the CFN building and improvements to land and utilities. These will be procured as one lump-sum competitively procured contract to a general contractor. The contractor will be selected based on an evaluated bid whereby the award is given to the firm meeting all technical, management, financial, past performance record and safety qualifications for this project at the lowest price.

D. WORK BREAKDOWN STRUCTURE DETAILS

1. As shown in **Figure 4-2**, the project WBS 1.0 – BNL Center for Functional Nanomaterials is divided into four main categories: Project Support 1.1, Technical Construction 1.2, Conventional Construction 1.3, and Standard Equipment 1.4. These items are further divided into major WBS elements.

2. WBS 1.1 - Project Support

   a. WBS 1.1.1 – Project Management - includes all work to manage the project in accordance with BNL's Project Execution Plan for DOE Order 413.3. The BNL Project Management Control System (PMCS) describes the procedure for the application of control systems, including control of project contingency. An Earned Value Management System (EVMS) conforming to ANSI standard EIA-748 will be used for performance management throughout the life of the project.

      1) WBS 1.1.1.1 – Project Management - Design Phase includes all work to manage the project during the design phase in accordance with BNL's Project Execution Plan for DOE 413.3. The BNL Project Management Control System (PMCS) describes the procedure for the application of control systems, including control of project contingency.

         a) WBS 1.1.1.1.1 – Project Mgmt Technical Design includes the management effort to support the technical phase of the project.

         b) WBS 1.1.1.1.2 – Project Mgmt Conventional Design includes the management effort to support the construction phase of the project.

      2) WBS 1.1.1.2 – Project Management - Construction Phase includes all work to manage the project during the construction phase in accordance with BNL's Project Execution Plan for DOE 413.3 and includes implementation of the BNL Construction Safety Program.

         a) WBS 1.1.1.2.1 – Project Mgmt Technical Construction includes all the project management effort to support the technical construction phase of the project.

b) WBS 1.1.1.2.2 – Project Mgmt Conventional Construction includes all the project management effort to support the conventional construction phase of the project.

b. WBS 1.1.2 – Project Engineering - includes Title I & II engineering, value engineering and Title III construction inspection services including implementation of the construction safety program.

1) WBS 1.1.2.1 – Project Engineering - Design Phase includes all work to design the project including Title I, Title II & Title III engineering.

a) WBS 1.1.2.1.1 – Project Engineering Technical Design includes all the project design effort to support the technical engineering phase of the project. This includes development of instrument specifications and procurement packages.

b) WBS 1.1.2.1.2 – Project Engineering Conventional Design includes all project design effort to support the conventional engineering phase of the project. This includes Title I and Title II design drawings and specifications, sustainable design, value engineering, and preparation of bid packages.

2) WBS 1.1.2.2 – Project Engineering - Construction Phase includes the engineering effort to support the construction phase of the project.

a) WBS 1.1.2.2.1 – Project Engineering Technical Construction includes all the engineering effort to support the technical construction during the construction phase of the project. This includes instrument procurement inspection, quality assurance, supervision of installation, supervision of start-up and commissioning.

b) WBS 1.1.2.2.2 – Project Engineering Conventional Construction includes the project engineering effort to support the conventional construction activity. This includes shop drawing review, construction inspection, quality assurance, supervision of start-up and commissioning of conventional facilities, utilities and systems.

3. WBS 1.2 – Technical Construction - Consists of competitively bid (where possible), lump sum contracts, as well as in-house fabrication, assembly, installation and testing. The tasks within each WBS element are broken down as follows:

   a. WBS 1.2.1 – Nanopatterning

      New state-of-the-art electron beam, ion beam, and deep ultraviolet patterning; plasma deposition, gas vapor deposition, and vacuum deposition; plasma, wet-chemical etching and appropriate packaging methods to fabricate nanomaterials with nanoscale precision.

   b. WBS 1.2.2 – Ultrafast Optical Sources

      These laboratories will be utilize standard and customized laser sources for the following applications: (1) ultrafast laser probes for examining issues in nanostructures, (2) new sources such as femto-second pulses and X-ray generation from laser-electron beam interactions, and (3) surface non-linear optical probes including second harmonic generation and semi frequency generation.

   c. WBS 1.2.3 – Electron Microscopy

      Planned for acquisition are two transmission electron microscopes including a 200kV instrument with a field emission gun. An ultra-high resolution scanning electron microscope will be available for examination of specimens and quantitative measurements. A sophisticated sample preparation lab will also be installed.

   d. WBS 1.2.4 – Materials Synthesis

      This suite of laboratories is designed to provide a range of thin film, bulk, and soft material synthesis capabilities. Preparation equipment included in these laboratories are a molecular beam epitaxy system, a pulsed laser deposition system, an electron beam evaporator, an arc furnace, and an induction furnace for crystal growth. Analytical and characterization facilities constitute a major portion of the investment. Equipment includes x-ray diffraction equipment, a magnetometer, and thermal properties measurement equipment.

e. WBS 1.2.5 – Proximal Probes

   Three laboratories are to be equipped for (1) a general user laboratory for optical characterization of samples using IR, UV and Raman spectroscopy and confocal microscopy, and near-field scanning optical microscopy (NSOM); (2) a development laboratory for spectroscopic near-field microscopy using IR and UV Raman techniques as well as a low energy electron microscope ; (3) a general purpose chemistry laboratory for sample preparation.

f. WBS 1.2.6 – Theory & Computation

   This laboratory cluster provides state-of-the-art software and computational equipment, i.e., a Linux cluster computer, with approximately 200 processors,

g. WBS 1.2.7 – CFN Endstations at NSLS

   A small angle x-ray scattering end station will be constructed by the BNL CFN. The major components of the end station are an area detector, position sensitive detector, scattering system, optics and microscopes.

4. WBS 1.3 – Conventional Construction - Consists of competitively bid, lump sum contracts. The tasks within each WBS element are broken down as follows:

   a. WBS 1.3.1 – Improvements to Land includes a new parking area to the northeast, reconfiguration of curbing and paving layout and vehicle access to the facility.

   b. WBS 1.3.2 – Buildings includes the foundation, structure, clean rooms, laboratories, offices, lounge areas and conference areas toilet rooms, mechanical spaces, and other support spaces.

   c. WBS 1.3.3 – Utilities includes bringing water, steam, sanitary, communication, data, chilled water, compressed air and electrical services to the building.

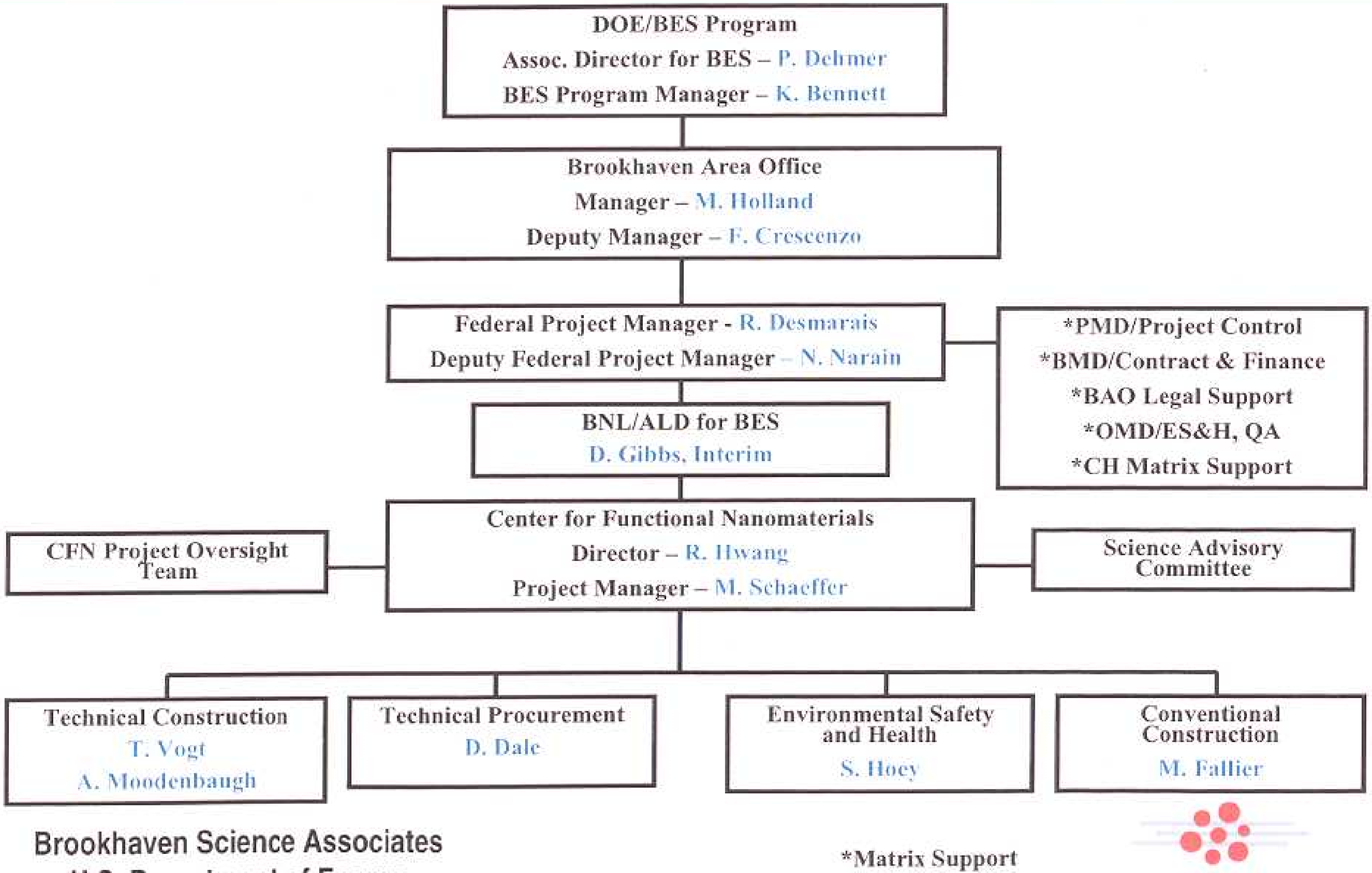
5. WBS 1.4 – Standard Equipment includes office furniture, personal computers, blinds and equipment that are off the shelf or only require nominal engineering.

E. PROJECT SCHEDULE

The design and construction <u>baseline schedule</u> for this project is detailed on the Gantt chart, **Figure 4-3**.

Figure 4-1

BNL CFN Integrated Project Team



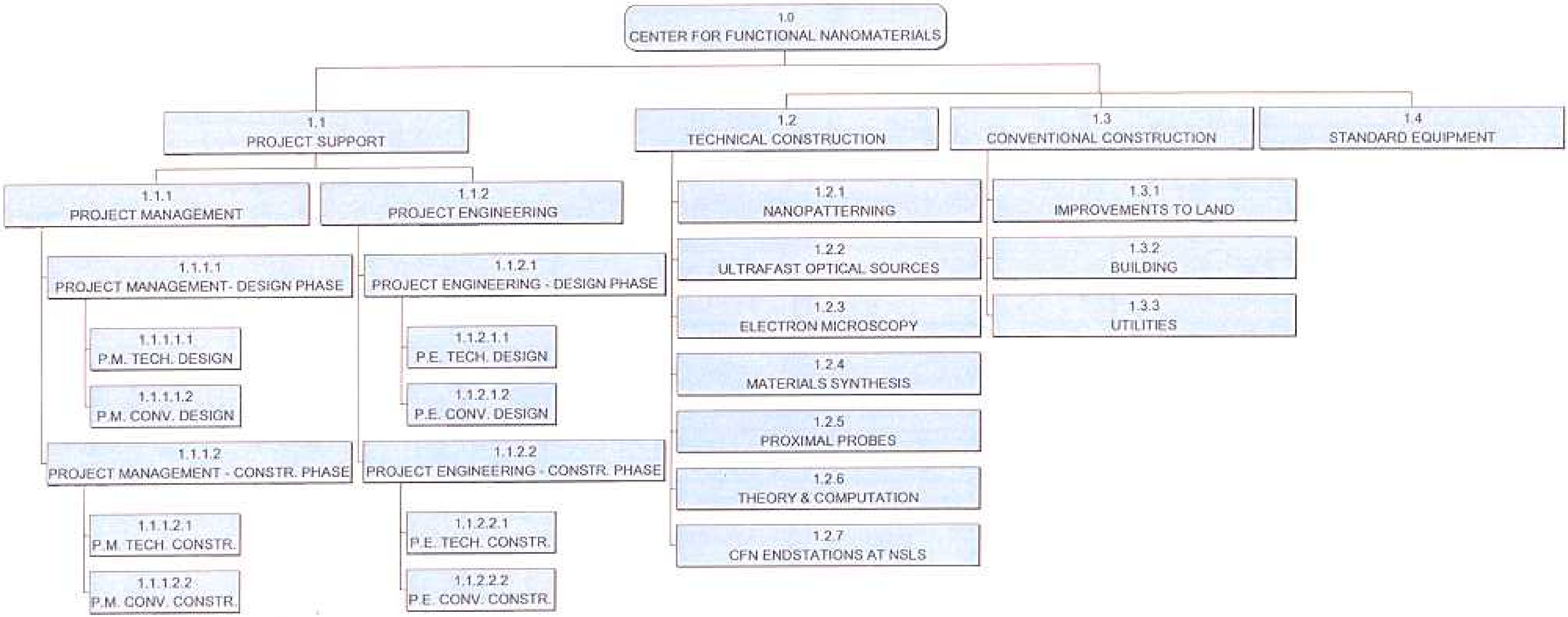
Brookhaven Science Associates
U.S. Department of Energy

Center for Functional Nanomaterials
Brookhaven National Laboratory

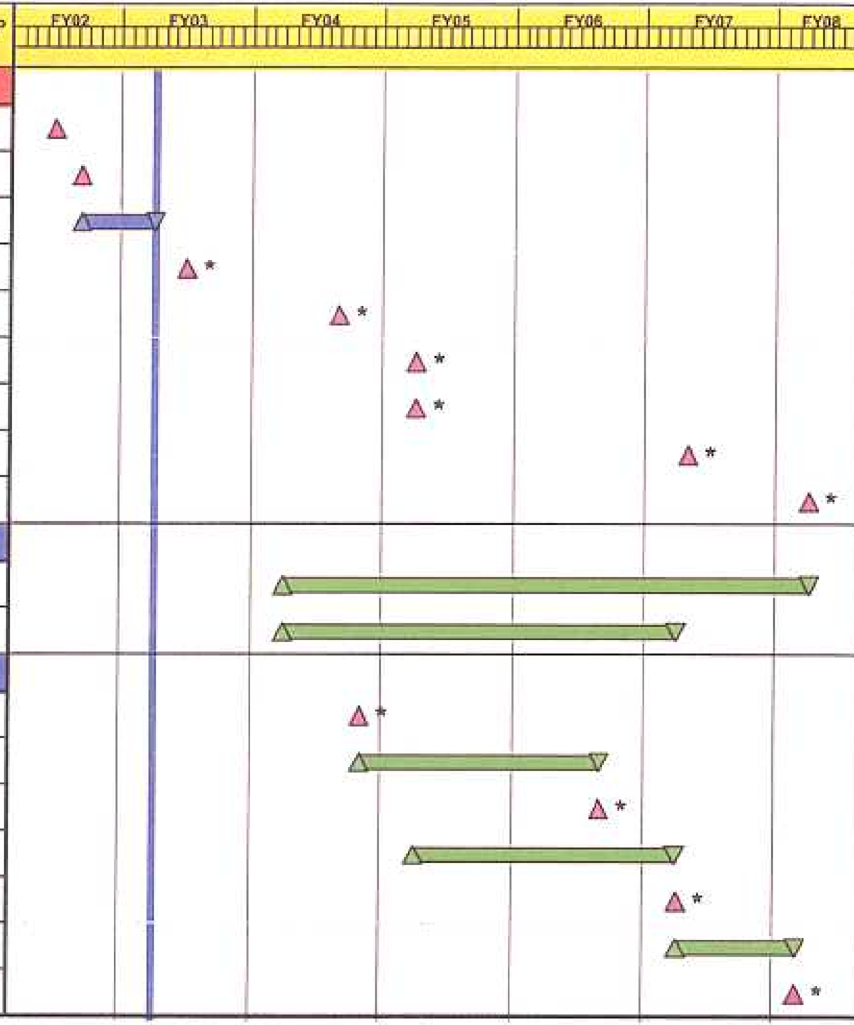
Figure 4-2

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

Work Breakdown Structure (WBS)



Activity Description	Early Start	Early Finish	RESP
1.0 Center for Functional Nanomaterials [C F N]			
N E P A APPROVAL		26MAR02A	MS
C D - 0 APPROVAL		12JUN02A	MS
CONCEPTUAL DESIGN REPORT	13JUN02A	31DEC02A	MS
C D - 1 APPROVAL-PRELIMINARY BASELINE *		31MAR03*	MS
C D - 2 APPROVAL-PERFORMANCE BASELINE *		28MAY04*	MS
C D - 3 APPROVAL-START CONSTRUCTION *	31DEC04*		MS
C D - 3 APPROVAL-START PROCUREMENT *	31DEC04*		MS
C D - 4A APPROVAL-TRANSITION & TURNOVER [BLDG] *		31JAN07*	MS
C D - 4B APPROVAL-START OF OPERATIONS *		31DEC07*	MS
1.1 Project Support			
PROJECT MANAGEMENT	02JAN04	31DEC07	MS
PROJECT ENGINEERING	02JAN04	29DEC06	MS
1.2 Technical Construction			
TECHNICAL DESIGN START *	02AUG04*		MS
TECHNICAL DESIGN	02AUG04	31MAY06	MS
TECHNICAL DESIGN COMPLETE *		31MAY06*	MS
PROCUREMENT	03JAN05	29DEC06	MS
START INSTALLATION *	02JAN07*		MS
INSTALLATION & TESTING	02JAN07	30NOV07	MS
INSTALLATION & TESTING COMPLETE *		30NOV07*	MS



Start Date	18NOV02
Finish Date	31DEC07
Data Date	01JAN03
Run Date	27JAN03 10:31

Early Bar
Progress Bar

CFN0 Sheet 1 of 2

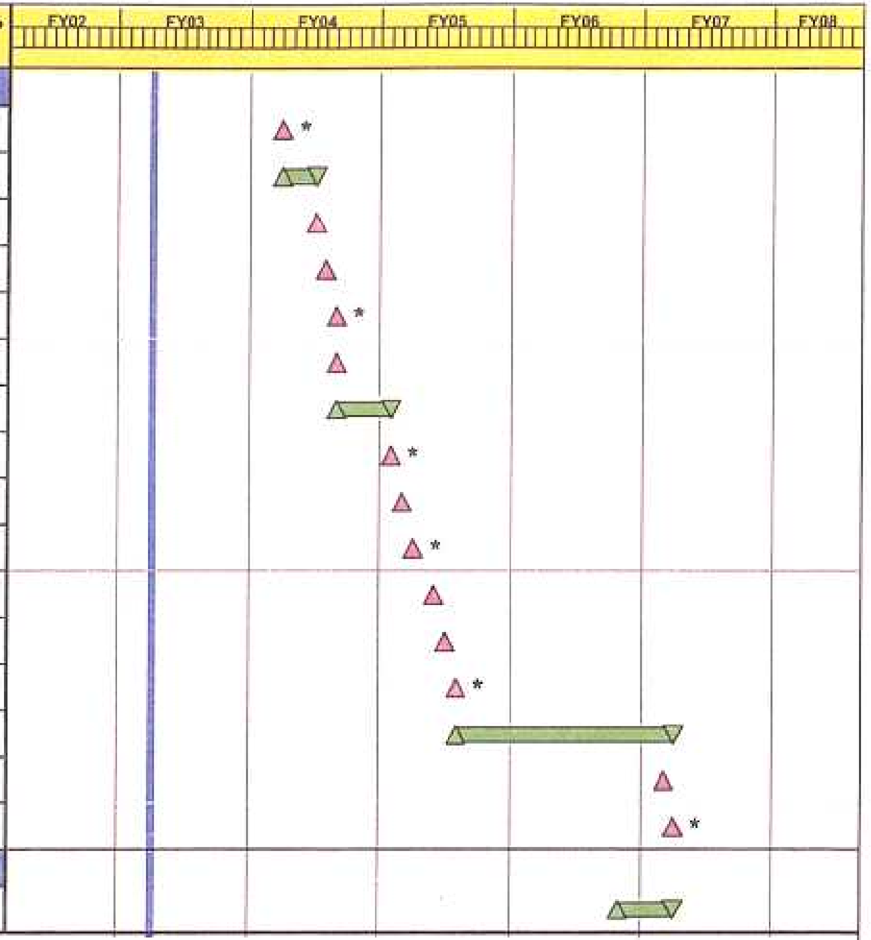
Brookhaven National Laboratory
CENTER for FUNCTIONAL NANOMATERIALS
[C F N]

Figure 4-3 Project Schedule

Approved by:
Mike Schaeffer
CFN Project Manager
* Major Milestone

Center for Functional Nanomaterials
Brookhaven National Laboratory

Activity Description	Early Start	Early Finish	RESP
1.3 Conventional Construction			
TITLE I START - CONVENTIONAL CONSTRUCTION *	02JAN04*		MS
PRELIMINARY DESIGN	02JAN04	31MAR04	MS
TITLE I PRELIMINARY DESIGN COMPLETE		31MAR04	MS
TITLE I APPROVAL		30APR04	MS
EXTERNAL INDEPENDENT REVIEW [E I R] *		28MAY04*	MS
TITLE II START	01JUN04		MS
DETAIL DESIGN	01JUN04	29OCT04	MS
TITLE II DETAIL DESIGN COMPLETE *		29OCT04*	MS
TITLE II APPROVAL		30NOV04	MS
INDEPENDENT PROJECT REVIEW [I P R] *		31DEC04*	MS
CONSTRUCTION CONTRACT AWARD	28FEB05		MS
CONSTRUCTION - NOTICE TO PROCEED	01APR05		MS
START CONSTRUCTION *	02MAY05*		MS
CONSTRUCTION	02MAY05	29DEC06	MS
COMPLETE O R E FOR OCCUPANCY		30NOV06	MS
CONSTRUCTION COMPLETE *		29DEC06*	MS
1.4 Standard Equipment			
PROCUREMENT, DELIVERY & INSTALLATION	01AUG06	29DEC06	MS



Start Date	18NOV02
Finish Date	31DEC07
Data Date	01JAN03
Run Date	27JAN03 10:31

© Primavera Systems, Inc.

Early Bar
Progress Bar

CFN0 Sheet 2 of 2

Brookhaven National Laboratory
CENTER for FUNCTIONAL NANOMATERIALS
[C F N]

Figure 4-3 Project Schedule

Approved by:

Mike Schaeffer
CFN Project Manager

* Major Milestone

Center for Functional Nanomaterials

REQUIREMENTS AND ASSESSMENTS

5

SECTION 5. REQUIREMENTS AND ASSESSMENTS

A. INTEGRATED SAFETY MANAGEMENT

The project will be performed in accordance with the approved and validated BNL Integrated Safety Management Program (ISM). These requirements are delineated in the Program Description for ISM within the BNL Standards Based Management System (SBMS), which is the governing institutional doctrine. The Center for Functional Nanomaterials (CFN) design, construction and operations are enveloped by this Program Description.

The BNL ISM makes the CFN Director responsible to execute the project in a manner that will not endanger the safety and health of workers, the public or the environment. As a means of ensuring that these goals are achieved, the guiding principles and core functions of ISM will be understood and applied by all project personnel in their management of ES&H functions and activities. Management of all aspects of the project to a "Zero Accident" goal will be an integral part of the overall CFN project mission.

Each phase of the CFN, from conceptual design through operational turnover and ongoing operations has and will continue to reiterate the ISM functions by implementing the following steps:

1. Review of project scope by subject matter experts (SMEs) for identification of hazards prior to design commencement to assure that engineering controls can be incorporated to mitigate hazards wherever feasible.

2. Review of completed design by SMEs to verify that hazards have been addressed and mitigated wherever feasible in the facility design and to assure appropriate safety requirements are included in design documents.

3. Selection of contractors based on their acceptable safety performance in addition to cost, commercial and technical qualifications.

4. Application of work control requirements that assure that contractors and in-house staff are not allowed to proceed with physical work until required safety documents (Safety Plan) are approved, all necessary training is completed and all applicable permits are in place.

5. Regular monitoring and inspection of project execution to assure all hazard mitigation requirements are properly carried out, and communication as needed to review and approve any changes in work controls to address changed conditions.

6. Evaluation of project execution for feedback and continuous improvement of the safety and work controls program.

7. Evaluation of contractor safety performance at project 50% and 100% completion points to provide feedback for contractor's safety program improvement and verify continued qualification to perform work at BNL.

Safety through design will be the primary driver throughout the design phases of the project. Complete management commitment and leadership and safety in the conduct of activities will continue as fundamental drivers through construction and turnover of the completed facility.

Following the transition to operations, the CFN Director will integrate the operation and maintenance of the completed facility and installed equipment into the existing BNL ESH management infrastructure.

B. SAFETY EVALUATION AND HAZARD ANALYSIS

All work will be accomplished in accordance with the U.S. Department of Energy Order 440.1 "Worker Protection Management for DOE Federal and Contractor Employees", DOE Order 5400.1 "General Environmental Protection", OSHA, and applicable Subject Areas in the Brookhaven National Laboratory Standards Based Management System.

1. Radiation

   This project will require minimal work in radiological controlled areas; radiation exposures to the workers and non-workers alike are expected to be insignificant.

2. Construction Safety

   All construction will comply with the latest edition of both OSHA Standards 29 CFR 1926 and 29 CFR 1910, and the BNL Standards Based Management System.

3. Safety Evaluation Form

   A preliminary safety evaluation has been performed for this project. A copy of the Safety Evaluation Form (EP-ES&H-500A) has been completed and reviewed by the BNL Environmental, Safety & Health Services Division and used as a baseline for the Preliminary Hazards Analysis. It is contained in Section 8, Appendix F. This form highlights important safety issues inherent in this project, which must be addressed during Title I, Preliminary Design and Title II, Detail Design.

4. Hazard Analysis

   A Preliminary Hazard Analysis (PHA) was completed for this project and is contained in Section 8, Appendix B. The PHA addresses both the conventional facilities as well as the technical facilities associated with the project. The CFN has been initially classified as a “Radiological” facility following the BNL Facility Hazard Categorization Subject Area. This is due to the potential for some of the proposed instrumentation to create radiological controlled areas during operation. The hazard level categorization will be refined as the PHA undergoes iteration in early Title I and Title II design and instrumentation parameters become better defined.

   The PHA developed during Conceptual Design will also serve as the initial baseline and safety basis for the CFN. The PHA identified construction, facility and operational hazards that will be addressed as the conceptual design phase progresses. Interaction with Project Staff and ESH Staff during the design phase will assure that any new hazards are appropriately identified and controlled.

C. ENVIRONMENTAL PROTECTION AND NEPA

A copy of the Environmental Evaluation form for NEPA Review of this project is included in Section 8, Appendix C. Environmental issues identified on the form have been considered in the conceptual design and appropriate costs included in the cost estimate. This project has been determined to be "Categorically Excluded" upon completion of the NEPA review.

The Environmental Management Program at BNL has been certified to meet the requirements of ISO 14001, the first DOE facility to achieve this certification. This standard evaluates the BNL program to certify that procedures, methods and controls exist and are properly implemented to assure protection of the environment for all activities, including design and construction and operations.

The potential sources of environmental impact were evaluated with respect to the construction activities planned for this project.

1. Excavation and Backfill

Excavation and backfill will be required to install the new parking lot and laboratory building. This may result in generation of noise and dust. The impact of such activity will be kept to a minimum. Dust will be controlled by spraying water. Noise from excavation equipment will be minimized through proper maintenance and will be conducted in remote areas which will not impact residences. Storm run-off during construction will be controlled through the use of silt fences.

2. Radiation

The scope of this project does involve placement of a new parking lot in an area where previous historical radiological contamination was remediated. It is anticipated that no radiation will be generated or released to the environment as a result of this project, however surveillance during parking lot excavation will be done.

3. Hazardous Waste

   It is anticipated that no hazardous wastes will be generated or released to the environment as a result of this project. If contaminants are discovered, materials will be segregated and packaged for disposal.

4. Emission Sources

   There are no air (NESHAPS) or water (NPDES) emissions sources which require specific permitting or modification to existing permits.

Sources of environmental impact for the operational phase of the CFN were evaluated in the Preliminary Hazard Analysis. This evaluation considered: generation of hazardous waste and industrial waste streams, radioactive waste, mixed waste, air emissions, infectious and biological waste and air emissions. Quantities of waste material will be low based on the anticipated usage of the facility. Quantities of radiological material, infectious and biological material are anticipated to be very low or nonexistent. The environmental impacts will be refined and documented in the PHA as the CFN undergoes iteration in early Title I and Title II design.

D. QUALITY ASSURANCE

1. BNL Quality Assurance (QA) Program (QAP)

   The project will be conducted in accordance with BNL's lab-wide Quality Assurance Program that applies to all work conducted at BNL. The BNL QAP conforms to the requirements of Department of Energy (DOE) Order 414.1A, Quality Assurance, and 10 CFR 830 Subpart A, Quality Assurance Requirements. BNL's QAP consists of the following ten Criteria:

   a. Program

   b. Personnel Training and Qualification

   c. Quality Improvement

   d. Documents and Records

e. Work Processes

f. Design

g. Procurement

h. Inspection and Acceptance Testing

i. Management Assessment

j. Independent Assessment

BNL's approach to satisfying the requirements of these criteria are delineated in the BNL Quality Assurance Program Description within the BNL Standards-Based Management System (SBMS). The Center for Functional Nanomaterial (CNF) design, construction and operation are subject to the QAP. A key element of the QAP is the concept of "Graded Approach", that is, applying an appropriate level of analysis, controls, and documentation commensurate with the potential to have an environmental, safety, health, radiological, or quality impact.

2. Center for Functional Nanomaterial QA Plan (CFN QAP)

The detailed CFN QAP will be developed prior to the start of Preliminary Design (Title I) and will address both the conventional and technical aspects of the project. This plan will address project activities from design through construction, as well as instrumentation and startup. A summary of the two major parts of the plan is as follows:

a. Technical Facilities

A major portion of the budget will be for sophisticated "off-the-shelf" and custom scientific equipment. Appropriate procurement controls, per SBMS requirements, will be applied to ensure the quality, delivery, and reliability of the equipment

Within SBMS, the Acquisition Management System (AMS) ensures that appropriate requirements and PAAA considerations (if applicable) are incorporated into contracts, i.e., Quality Assurance, Integrated Safety Management. Also, the AMS ensures that procured items and services meet the established requirements, perform as specified, and meet the expectations of the end-user. The stringency of the procurement requirements is commensurate with the importance of the purchased items or services to the project.

Based on the "graded approach," potential suppliers of critical, complex, or costly items or services undergo an evaluation, before contract award, to determine if they can consistently conform to the technical and quality requirements of the procurement.

The AMS includes a post-award administration process that ensures that suppliers satisfy the requirements of the contract. These activities include, as appropriate to the specific procurement, in-process inspection, product acceptance testing – either at the vendor site, or upon arrival at BNL, and/or documentation of certifications of conformance to specifications.

b. Conventional Facilities

This effort applies to the basic design and construction of the building and will be executed by the BNL Plant Engineering Division (PE). PE uses the SBMS and corresponding local procedures, as applicable, to perform work. Using the processes and requirements delivered through SBMS, PE has established processes for planning, achieving, and assessing their activities. Thus PE satisfies the requirements of a project and assures the quality of all aspects of Titles I, II and III.

E. RISK MANAGEMENT STRATEGY

1. Risks anticipated for this project will be managed using a graded approach in accordance with the methodology identified in the DOE Order for Program and Project Management for the Acquisition of Capital Assets, O 413.3. A Risk Management Plan (RMP) has been prepared for this project and is contained in Section 8, Appendix E. The RMP identifies the scope of the project's risk definition and delineates the

methodology that has been used to identify, quantify and assess risks. The level of treatment is graded based on the risk level determination. The plan identifies the controls and processes used to identify and mitigate areas of cost, scope, schedule, and technical risk that may occur during project planning and implementation. The RMP will be maintained throughout the life of the project.

2. The CFN Project Manager is responsible for applying the risk management methodology during the conceptual design, preliminary design and detailed design phases of the project as well as incorporating risk based decision processes during the construction phase. The risk management methodology is further defined in the CFN RMP provided as Appendix E.

3. Risk management during the design phases will include an assessment of the technical, cost and schedule risks at each phase of design development. Risks will be assessed at WBS level three as a minimum and will take into account the probability of a detrimental occurrence as well the severity of impact for that occurrence. The project execution plan, acquisition plan, cost estimates and schedule shall all be prepared given awareness of the project risks and incorporate risk mitigation strategies to the maximum extent feasible.

4. The elements of risk for technical, schedule and cost baselines shall be converted to cost impacts and adjusted by the probability and severity of occurrence. These costs will form the basis for project contingency costs and shall be applied at WBS level three as a minimum. Projected contingency costs shall be adjusted during each project phase as risks are encountered and addressed or mitigated. The CFN Project Manager is responsible for managing project contingency, as agreed upon with the DOE BAO Project Manager, with the objective of maintaining contingency commensurate with project risks during all phases of the project through completion.

F. SAFEGUARDS AND SECURITY REQUIREMENTS

The security requirements for this project are typical of BNL construction of conventional research facilities. There are no additional security requirements associated with this project that are not already addressed by BNL user facilities of similar scope such as the NSLS. Access to the CFN will be controlled by a card reader access system that will assure that only authorized staff, users or visitors can gain entry to restricted areas. Issuance of access cards will be governed by BNL's SBMS requirements for Identification and Access for Employees, Guests and Visitors.

G. VALUE ENGINEERING

Value Engineering (VE) will be performed for this project as required under DOE Order 413.3, "Program and Project Management for the Acquisition of Capital Assets." An independent value engineering team will perform VE review during Title I design. A VE report will be provided to the CFN Project Manager and DOE/BAO Project Manager for consideration and, where feasible, incorporation in project design documents.

The VE review will be a systematic review of the mature Title I design performed by an independent team of qualified consultants and/or in-house staff. The team will comprehensively review design elements and material selections with regard to their needed level of performance and quality. Alternate methods, elements and selections that meet the necessary performance and quality will be considered. The comparative first cost and life cycle cost of these alternatives will be determined and compared to the original design. A VE report will be prepared indicating alternatives considered, their respective costs and recommendations as to which alternatives should be implemented in the project design.

H. SUSTAINABLE DESIGN

This project will be designed to meet the requirements for Sustainable Design in DOE Order 413.3. The project A/E design team will include architectural and engineering staff trained in sustainable design, familiar with Leadership in Energy and Environmental Design (LEED) rating criteria, and recommendations of the Green Building Council. The BNL project team will also include an environmental engineer responsible for identifying pollution prevention opportunities and a certified energy manager / energy engineer responsible for identifying energy savings opportunities and performing an energy analysis. The project A/E will prepare an application for LEED's certification for the project. The project design objective will be to achieve the highest LEED rating possible consistent with mission functional requirements and the established project budget.

I. FACILITY COMMISSIONING

An important element in the ultimate success of the CFN will be proper commissioning of the facilities systems and instruments. The extreme sensitivity of research at the nanoscale requires that all systems and instruments achieve their maximum performance capability to fulfill the research mission. Additionally, any systems or equipment that can create environmental disturbance must be properly calibrated, balanced, tuned or shielded to prevent detrimental impact to the research. During the Title I Design phase, a detailed Facility Commissioning Plan will be prepared to assure that appropriate commissioning requirements have been included in the CFN design. The commissioning plan will:

- Present a schedule and sequence for start-up of building systems and instruments, including any dependencies linked to the conventional or technical construction schedule.
- Identify systems and instruments at the equipment level that will require commissioning.
- Identify references and sources of start-up procedures and performance, test and acceptance criteria for the instruments and equipment.
- Identify whether the equipment will be commissioned by BNL staff, contractor staff, vendor staff or if the services of a specialty commissioning contractor are warranted.
- Identify the point at which equipment has been accepted and can be turned over to operations staff.
- Be updated during the Title II and Title III phases as appropriate to reflect changes in equipment selection and performance.

OUTLINE SPECIFICATIONS

6

SECTION 6. OUTLINE SPECIFICATIONS

A. DESIGN CRITERIA

1. The latest edition of the codes, orders, standards, and guides referred to in this section will be followed and in accordance with BNL's Implementation Plan for DOE Order 413.3, Program and Project Management for the Acquisition of Capital Assets.

2. Department of Energy (DOE) Orders

   a. DOE 5480.4 - Environmental Protection, Safety and Health Standards

   b. DOE 5480.9 - Construction Safety and Health Program

   c. DOE 5700.6B - Quality Assurance

3. Codes, Standards and Guides

   a. American Concrete Institute

   b. American National Standards Institute

   c. American Society of Mechanical Engineers

   d. American Society for Testing Materials Standards

   e. American Water Works Association

   f. American Welding Society

   g. Factory Mutual

   h. ICEA Insulated Cable Engineering Association

   i. Industrial Control Standards (NEMA)

   j. IEEE Institute for Electrical and Electronic Engineers

   k. National Bureau of Standards

   l. National Electrical Code

   m. National Electrical Manufacturers Association

   n. National Fire Prevention Association

   o. Occupational Safety and Health Administration

p. Underwriters Laboratory

q. Uniform Mechanical Code

r. Uniform Plumbing Code

4. Local Codes

a. BNL Environment, Safety and Health Standards

b. New York State and Suffolk County Department of Health Codes.

B. CSI DIVISION 2 THROUGH 16

DIVISION 2 - SITE WORK

A. PROJECT INCLUDES:

1. Site Preparation
   a. Protection of existing trees, vegetation, landscaping materials, and site improvements.
   b. Trimming of existing trees and vegetation.
   c. Clearing and grubbing of stumps, vegetation, debris, and rubbish.
   d. Topsoil stripping and stockpiling.
   e. Temporary erosion control.
   f. Temporary protection of adjacent property.
   g. Removal and legal disposal of cleared materials.
2. Earthwork
   a. Excavation, filling, compaction, and grading.
   b. Materials for sub base, drainage fill, and backfill.
   c. Removal and legal disposal of excavated materials.
   d. Compaction:
      1) Under structures, building slabs, steps, pavements, and walkways, 95 percent maximum density, ASTM D 1557.
      2) Under lawns or unpaved areas, 90 percent maximum density, ASTM D 1557.
3. Hot-Mixed Asphalt Paving
   a. Asphalt-Aggregate Mixture: Plant-mixed, hot-laid asphalt-aggregate mixture, ASTM D 3515, complying with local DOT and DPW regulations.
   b. Prime Coat: Cut-back asphalt, ASTM D 2027.

c. Tack Coat: Emulsified asphalt, ASTM D 977.

d. Lane and Parking Area Marking Paint, White Color: Alkyd-resin type, ready-mixed, AASHTO M 248, Type I.

4. Landscape Work

a. Finish grading and lawns. Seed, new crop mixture.

b. Topsoil and soil amendments. Neutral character for lawns.

DIVISION 3 - CONCRETE

A. QUALITY ASSURANCE

1. Standards: ACI 318, Building Code Requirements for Reinforced Concrete, and CRSI Manual of Standard Practice.

2. Testing: Independent testing laboratory.

B. PROJECT INCLUDES

1. Cast-in-Place Concrete

a. Concrete Design Mixes, ASTM C 94, 28 Day Compressive Strength:

1) Columns, Beams, Walls, Foundations, and Footings: 4000 psi.

2) Slabs on Grade: 4000 psi.

3) Exterior Site Concrete and Pads Exposed to Weather: 4000 psi.

b. Formwork: Plywood or metal panel formwork.

c. Reinforcing Materials:

1) Epoxy coated Reinforcing Bars: ASTM A 615, Grade 60, deformed.

2) Steel Wire: ASTM A 82.

3) Fiberglass Wire Fabric: ASTM A 185, welded.

DIVISION 4 - MASONRY

A. QUALITY ASSURANCE

1. Standards: ACI 530.1, Specifications for Masonry Structures.

2. Fire Performance: ASTM E 119.

3. Testing: Independent testing laboratory.

4. Field-Constructed Mock-Up: Typical exterior metal siding and fenestration construction.

B. PROJECT INCLUDES:

1. Unit Masonry
    a. All non-bearing interior and exterior accent face brick, and exterior brick paving.
        1) Brick: ASTM C-216 Grade SW, Type FBS, 2-1/4" high x 3-5/8", solids.
    b. All hollow concrete masonry units, ASTM C 90, normal weight.
    c. All welded wire and steel bar reinforcing, anchors, clips, setting of loose lintels.
    d. All mortar, parging and grouting, control and weather joints.
        1) Mortar Mix: Type M or S, Portland Cement and hydrated lime, ASTM C-270.
    d. Required cutting and patching, pointing and cleaning.
    e. Framing of doors, windows and mechanical items.
    f. Required flashing of all openings, lintels, etc. in masonry walls.

DIVISION 5 - METALS

A. QUALITY ASSURANCE

1. Standards:
    a. American Institute of Steel Construction (AISC), “Specification for Structural Steel Buildings”, and applicable regulations.
    b. Steel Joist Institute Standard Specifications.
    c. AISI, “Specification for the Design of Cold-Formed Steel Structural Members”; and SDI “Design Manual for Composite Decks, Form Decks, and Roof Decks.”
    d. Handrail and Railing Structural Performance: ASTM E 985.

B. PROJECT INCLUDES:

1. Structural Steel Framing
    a. Structural Steel Shapes, Plates, and Bars: ASTM A 36.
    b. Cold-Formed Steel Tubing: ASTM A 500, Grade B.
    c. Steel Pipe: ASTM A 53, Type E or S, Grade B; or ASTM A 501.
    d. Headed Stud-Type Shear Connectors: ASTM A 108, Grade 1015 or 1020.
    e. Anchor Bolts: ASTM A 307, nonheaded type.

    f. High-Strength Threaded Fasteners: ASTM A 325 or ASTM A 490, as applicable.

2. Steel Joists
    a. Type: LH-series Longspan steel joists.
    b. Steel: SJI specifications for chord and web sections.
    c. Steel Bearing Plates: ASTM A 36.
3. Steel Deck
    a. Type: Steel for painted metal deck, ASTM A 611.
    b. Steel Shapes: ASTM A 36.
    c. Shear Connectors: Headed stud type, ASTM A 108.
    d. Sheet Metal Accessories: ASTM A 526, commercial quality, galvanized.
    e. Paint: Baked-on rust-inhibitive paint.
4. Cold-Formed Metal Framing
    a. Cold-Formed Metal Framing Units:
        1) Bracing of exterior masonry veneer.
        2) Stud Type: C-shaped load-bearing steel studs for walls.
            a) Units 16 gage and heavier: ASTM A 446, A 570, or A 611.
            b) Units 18 gage and lighter: ASTM A 446, A 570, or A 611.
            c) Finish: Galvanized, ASTM A 525, G60.
        3) Auxiliary Materials
            a) Fasteners.
            b) Electrodes for welding.
            c) Galvanizing repair, ASTM A 780.
5. Metal Fabrications
    a. Metal stairs.
    b. Steel pipe railings.
    c. Ladders.
    d. Nosings.
    e. Cast treads and thresholds.
    f. Loose bearing and leveling plates.
    g. Loose steel lintels.
    h. Framing and supports for suspended toilet partitions.
    i. Framing and supports for suspended operable partitions.
    j. Miscellaneous steel trim.
    k. Shelf and relieving angles.

l. Floor plate and supports.
m. Tread plate and supports.
n. Pipe bollards.
o. Elevator entrance sill angles.
p. Rough hardware.

DIVISION 6 - WOOD AND PLASTICS

A. QUALITY STANDARDS
1. Lumber Standards and Grade Stamps: PS 20, American Softwood Lumber Standard and inspection agency grade stamps.
2. Preservative Treatment: AWPA C2 for lumber and AWPA C9 for plywood; waterborne pressure treatment.

B. PROJECT INCLUDES:
1. Rough Carpentry
   a. Framing with dimension lumber.
   b. Rooftop equipment bases and support curbs.
   c. Wood grounds, nailers, and blocking.
2. Finish Carpentry
   a. Interior Standing and Running Trim and Rails:
      1) Species and Grade: Clear dry red oak, defect-free.
      2) Fasteners: Concealed and countersunk fasteners.
      3) Finish: Semi-transparent stain.
   b. Plywood Paneling:
      1) Type: Hardwood veneer paneling, ANSI/HPMA HP.
      2) Species: Rotary cut natural birch veneer, ANSI/HPMA HP.
      3) Core: Lumber.
      4) Face Pattern: Plain.

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

A. PROJECT INCLUDES:
1. Foundation Wall Cold-Applied Asphalt Emulsion Dampproofing:
   a) Materials and Application: Semi-fibrated mastic type, ASTM D 1227, Type II, 30 mils.
   b) Protection Course: Compatible with dampproofing.

2. Foundation Perimeter Insulation: Extruded polystyrene, rigid, ASTM C 578, 1" thick x 18" wide.
3. Brick Water Repellent: Huls “Cheme-Trete PB VOC” applied in accordance with manufacturer’s recommendations.
4. Fiberglass Cavity Wall Insulation: Rigid board, R=11.
5. Polyisocyanurate Foam Board Roof Insulation: 3″ thick, R=19.
6. Underslab Vapor Barrier: Continuous 6 mil polyethylene.
7. Fireproofing: Cementitious, ASTM E 605.
8. Built-Up Roofing: FM Class 1 construction, 3-ply plus coating, UL Class A.
9. Sheet Aluminum Flashing, Facia and Gravel Stops: ASTM B 209, alloy 3003, gauged to suit application.
10. Elastomeric Sealants: One part, silicone, ASTM C 920, interior and exterior, in matching colors.
11. Manufactured Wall Panels: Factory-assembled insulated wall panels with gasketed seams, panel supports, and anchorage.
    a) Finish Warranty: 20 years.
    b) Sheet Materials: Aluminum sheet, ASTM B 209, Alclad Alloy 3003, 0.040 inch.
    c) Panel Core: Glass fiber board insulation.
    d) Finish: Fluoropolymer, Kynar 500.
    e) Panel Supports and Anchorage:
        1) Wall Girts: C or Z shaped sections, 16 gage steel, shop painted.
        2) Flange and Sag Bracing: 16 gage steel, shop-painted.
        3) Base and Sill Angles: 14 gage galvanized steel.
        4) Secondary Structural Members: 14 gage galvanized steel.

DIVISION 8 - DOORS AND WINDOWS

A. QUALITY ASSURANCE
1. Standards: ANSI/SDI-100, Recommended Specifications for Standard Steel Doors and Frames.
2. Performance Standards:
    a. Fire-Rated Assemblies: NFPA 80, and acceptable testing agency listing.
    b. Thermal-Rated Assemblies at Exterior: ASTM C 236 or ASTM C 976.

B. PROJECT INCLUDES:
1. Steel Frames

a. Furnish and install welded 16 ga steel door frames.

2. Steel and Wood Doors
   a. Furnish and install 1¾″ thick hollow metal steel and solid core wood doors, as indicated and reinforced for hardware.
   b. Doors, where required, shall be fire doors and shall bear appropriate UL label. Include sound seals and extruded aluminum saddles at Equipment Rooms.
   c. Furnish and install all access doors.
3. Hardware
   a. Locks shall be keyed, sub-mastered, and master keyed as required to suit BNL Best standard locking system.
   b. Work includes, but is not limited to, butts, lock and latch sets, rosettes, escutcheons, push plates, pulls, door mutes, closers, stops, holders, panic devices, and all other items necessary to complete the work.
4. Aluminum Windows
   a. Furnish and install factory finished anodized aluminum windows complete with aluminum framing and 1" insulated glass.
      1) Aluminum windows shall be sized as indicated, extruded anodized aluminum with mitered corners.
      2) Aluminum framing shall be manufacturer's standard shapes.
      3) Glass for windows shall be PPG or approved equal, 1" insulating glass. Insulating glass will consist of 2 sheets of 1/4" plate glass with a sealed air space between.
      4) Interlock elastomeric weatherstripping securely to inside and outside of weathering contacts.

DIVISION 9 - FINISHES

A. QUALITY ASSURANCE
   1. Performance: Fire, structural, and seismic performance meeting requirements of building code and local authorities.

B. PROJECT INCLUDES:
   1. Acoustical Ceilings
      a. For office areas, furnish and install 2' x 2' lay-in suspended acoustical grid ceiling.

b. Tile shall be mineral composition and have 0-25 flame spread and 0-50 smoke developed ratings.

2. Steel Stud Partitions and Furring
   a. All partitions, except masonry, shall be constructed of 25 gauge, 3-5/8" steel studs, spaced 16" o.c.
3. Gypsum Wallboard
   a. Gypsum wallboard shall be furnished and installed on both faces of all steel stud partitions.
   b. Gypsum wallboard shall be 1/2" thick.
   c. Gypsum wallboard walls shall have all joints finished with tape and joint cement.
4. Resilient flooring
   a. Furnish and install resilient floor and base throughout office areas.
   b. Floor tile shall be vinyl composition, 12" x 12" x 1/8" thick.
   c. Base shall be colored vinyl throughout. 1/8" thick, 4" high, installed in longest possible lengths.
   d. All required vinyl reducing strips shall be included.
5. Carpet
   a. Fire performance shall meet NFPA for smoke development and flame spread.
   b. Structures Enhancer III Plus 12'-0" roll goods, Stratton Industries, tufted loop pile nylon, glue down.
   c. Hammered aluminum accessories, vinyl edge strips.
6. Painting and Finishing
   a. Exterior
      1) All exterior steel, rails, trim, etc. shall be shop or site primed and finished with 2 coats of exterior alkyd enamel.
   b. Interior
      1) Interior walls shall receive one coat of primer and two coats of latex satin paint.
      2) Exposed primed steel shall be given two spray coats of semi-gloss alkyd.

DIVISION 10 - SPECIALTIES

A. PROJECT INCLUDES:

1 – Clean Rooms

a. Standards:

ISO 14644- Part 1 Classification of air cleanliness

ISO 14644- Part 2 Specifications for testing & monitoring

ASHRAE Handbook Fundamentals

Institute of Environmental Sciences and Technology (IEST) Recommended Practices:

IEST-RP-CC001.3: HEPA and ULPA Filters

IEST-RP-CC006.2:Testing Clean rooms

NFPA 318 for standards for the protection of clean rooms

b. A controlled clean environment shall be provided within which all mechanical, electrical and clean room systems, and process piping, will be installed.

c. Clean environment shall be maintained from the initial construction stage through final clean room certification.

d. Products brought into the Clean Zone shall comply with minimum cleanliness standards on both interior and exterior surfaces.

e. Personnel cleanliness levels and construction protocol standards shall be established and monitored for each construction stage.

f. Active contamination controls shall be enforced consistent with each construction stage.

g. Required level of cleanliness shall be monitored using spot checks at prescribed locations.

h. Clean rooms shall be constructed by a Clean room Contractor responsible for compliance with the documents.

i. Clean room Contractor shall employ and pay for the services of a qualified Clean room testing and Certification Agency to perform services specified.

j Clean room Testing and Certification Agency shall be independent from the Clean room Contractor, system manufacturer and installer.

k Clean Zone Boundaries:

1) Clean Zone includes clean rooms indicated on drawings, and remote rooms for clean room support equipment, bounded by and inclusive of:
2) Top of isolation floor slab below.
3) Bottom of structural slab above.
4) Perimeter walls on all sides.

l. Clean room Systems

Architectural elements:

1) Modular partitions: Prefinished relocatable panels , with integral structural framing and supports, doors, windows, gaskets, sealants and accessories.
2) Access floor: Manufacturer's static dissipative raised access flooring system.
3) Ceiling system: Manufacturer's flow through grid ceiling system, with recessed lighting and HEPA filter assembly.
4) Equipment support system.

m. HVAC systems:

1) Recirculating air handling unit system including ductwork, plenums, piping, dampers, coils, sound attenuators, mounting, connection to filters and connection to make-up air handling unit system.
2) Air handling units.
3) Sound attenuators.
4) Grilles, registers, floor panels and HEPA filters in addition to those included in the modular partitions, access floor and flow-through grid ceiling system.

n. Piping systems:

1) Process chilled water from valved connections.
2) Process chilled water to laboratory and heat exchangers.
3) Valves.

o. Plumbing systems:

1) Ultra pure water from valved loop.
2) Indirect waste to floor drain.
3) Indirect solvent waste to holding tanks.
4) Gases from valved loop.

5) Ultra pure water and indirect waste to and from laboratory equipment.

p. Fire Suppression systems:

1) Sprinkler heads and run-out from branches.
2) Branches from cross mains.
3) Electrical elements.

q. Lighting in addition to fixtures included in the flow-through grid ceiling system.

r. Grounding of raised floor system.

s. Installation of branch circuits including wiring, conduit and disconnects in clean room and chases.

t. Panelboards in chases.

2. Toilet Partitions

a. The work shall consist of furnishings and installing all steel toilet compartment partitions and urinal screens, as shown on the drawings.

b. Partitions and screens shall be flush type, consisting of two sheets of 22 gauge galvanized steel installed over a honeycomb core, with baked enamel finish.

c. All fittings shall be tamperproof chrome plated brass.

3. Toilet Accessories

a. The work shall consist of furnishing and installing all required toilet room accessories, including mirrors, paper holders, paper towel receptacles and dispensers, soap dispensers, napkin receptacles, grab bars in toilets for the handicapped, etc.

b. In general, all accessories shall be fabricated of stainless steel.

DIVISION 14 - CONVEYING SYSTEMS

A. QUALITY ASSURANCE

1. Safety Code: ASME/ANSI A17.1, local regulations and handicapped requirements.

B. PROJECT INCLUDES

1. Pre-engineered electric traction elevators:

a. Passenger elevators and combined passenger/service elevator.

2. Features and Components:
   a. Type: Geared traction type (up to 400 fpm).
   b. Control Systems: Multiple elevator controls.
   c. Cab Finishes: Plastic laminate panels and carpet.
   d. Door Panels: Enamelled steel.
   e. Hoistway Entrances: Enamelled steel.
3. Auxiliary Operations and Controls:
   a. Key controlled car light switch and fan switch.
   b. Alarm/emergency stop button.
   c. Car position and direction indicators.
   d. Audible signals.
   e. Automatic 2-way leveling.
   f. Key switches to lockout individual floors.
   g. Door nudging device.
   h. Liner blanket hooks and blankets.
   i. Emergency power operation.
   j. Two-way telephone communication.
4. Electric Traction Geared Passenger Elevator Schedule:
   a. Capacity: 4,000 pounds.
   b. Speed: 200 feet per minute.
   c. Landings Served: Two floors.
   d. Entrance Size: 3'-6" by 7'-0".
   e. Entrance Door Operation: Center opening.
   f. Power Supply: 208 volt, 3 phase, 60 Hz.
5. Electric Traction Geared Freight Elevator Schedule:
   a. Capacity: 10,000 pounds.
   b. Speed: 200 feet per minute.
   c. Landings Served: All floors.
   d. Entrance Size: 3'-6" by 7'-0".
   e. Entrance Door Operation: Center opening.
   f. Power Supply: 208 volt, 3 phase, 60 Hz.

DIVISION 15 - MECHANICAL

A. QUALITY ASSURANCE

1. The following documents of the issue in effect on the date the Contract is let, form a part of this Specification to the extent specified.
    a. ANSI - American National Standards Institute
    b. ARI - Air Conditioning and Refrigeration Institute
    c. ASME - American Society of Mechanical Engineers
    d. ASTM - American Society for Testing and Materials
    e. AWWA - American Water Works Association
    f. CFR - Code of Federal Regulations
    g. EPA - Environmental Protection Agency
    h. FM - Factory Mutual
    i. NSPC- National Standard Plumbing Code
    j. NEMA - National Electric Manufacturers Association
    k. NFPA- National Fire Protection Association
    l. OSHA- Occupational Safety and Health Administration
    m. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
    n. UL- Underwriters Laboratories, Inc.
    o. USPHS - United States Public Health Service

B. PROJECT INCLUDES:
1. Air Conditioning and Heating System
    a. Summer Outdoor Conditions: 95° F. (35° C.) dry bulb, 76° F. (24° C.) wet bulb.
    b. Winter Outdoor Conditions: 0° F. (-18° C.) dry bulb, 15 mph NW wind.
    c. Summer Indoor Conditions: 76° F. (24° C.) plus or minus 1° F degrees; 55 percent relative humidity plus or minus 5 percent.(lab spaces), plus or minus 2° F degrees; 55 percent relative humidity plus or minus 5 percent (balance of building)
    d. Winter Indoor Conditions: 72° F. (22° C.) plus or minus 1° F degrees. (lab Spaces), plus or minus 2° F degrees. (balance of building)
2. Exhaust System
    a. Exhaust system serving the toilet rooms and kitchen/lunch room shall consist of independent exhaust fans and backdraft dampers.
3. Automatic Temperature Controls
    a. Provide a fully automatic system for control of temperature where specified.

b. System shall be electronic, as manufactured by AutomatedLogic corp., compatible with the existing WebCTRL Energy Management Control System (EMCS).

c. System shall have calibrated precision temperature sensors for all critical temperature environments.

4. Sheetmetal Work

   a. All sheetmetal ductwork shall meet the requirements of the latest edition of the ASHRAE Guide and SMACNA, and shall include balancing dampers, fire dampers, access doors, diffusers, registers, and automatic dampers, as required.

5. Insulation Materials

   a. All pipe and duct insulation in building shall have a composite fire and smoke rating not to exceed flame spread of 25; fuel contributed of 50 and smoke developed of 50, ASTM E-84, NFPA 255 and UL 73.

   b. Thickness and type of insulation as per manufacturer's recommendations.

   c. Asbestos or asbestos-containing insulation materials will not be accepted.

6. Fire Protection

   a. A hydraulically designed supervised automatic wet pipe sprinkler system shall be provided with sprinkler control valve and water flow device for each floor.

   b. System shall include a Class 1 standpipe system.

   c. All work shall meet requirements of NFPA 13 " Standard for Installation of Sprinkler Systems ", NFPA 72 National Fire Alarm Code, and NFPA 101 Section 32-8.

   d. Provide at locations in accordance with appropriate NFPA requirements 10 pound ABC Dry Chemical Extinguisher in cabinets.

7. Sanitary, Waste and Vent Systems

   a. All work shall meet the requirements of NSPC.

   b. Pipe and Fittings: Service weight hub and spigot cast iron soil pipe and fittings, ASTM-A74 and ANSI - A112.5.1.

   c. Waste and Vent Piping 1½" and Under: Standard weight galvanized steel pipe conforming to ASTM - A120 and ANSI - B125.2.

   d. Waste and Vent Piping 2" and Over: Service weight hub and spigot cast iron soil conforming to ASTM-A74 and ANSI-A112.5.1.

e. Water closets shall be wall mounted, syphon jet, with flush valve.
f. Urinals shall be wall mounted with flush valve.
g. Lavatories shall be 20" x 18" vitreous china.
h. Floor and outlet slop sinks.
i. Kitchen sinks.
j. Reduced pressure zone backflow preventer.

8. Steam and Condensate Systems
   a. All work shall meet requirements of ANSI-B31.1 “Code for Pressure Piping.”
   b. Pipe and Fittings: Schedule 40 black steel pipe conforming to ASTM-A106 with seamless standard class carbon steel butt welded fittings conforming to ASTM-A234.
9. Hot Water Heating System
   a. Pipe and Fittings: Schedule 40 black steel pipe conforming to ASTM - A53 with standard 150 lb. class malleable iron screwed conforming to ASTM - B16.3 on 2” and under or seamless standard class carbon steel butt welded conforming to ASTM – A234 fittings. Type L hard drawn copper tubing may be used in lieu of schedule 40 black iron steel on pipe 2” and under.
10. Identification of Piping Systems
   a. All piping system identification shall meet requirements of ANSI - A13.1 "Scheme for the Identification of Piping Systems," and ANSI - Z1353. 1 " Safety Color Code for Marking Physical Hazards," and the BNL ES&H Standards.
   b. Provide piping content identification legends and directional flow arrows on all systems installed under this Contract. Where flow is multi-directional, use double headed arrows.
   c. Provide systems having temperatures above 120°F. with legends indicating those temperatures.
11. Mechanical Sound and Vibration Control
   a. Comply with ASHRAE, ASTM, AASHO standards
   b. Provide proper type and class of vibration isolators for all pumps, fans, blowers, and other rotating machinery including neoprene rubber, spring type isolators.
   c. Provide machinery support including steel frame, concrete filled , cast-in-place concrete and curb mounted base.

d. Provide piping connections for vibration isolation including Neoprene EPDM straight and elbow types, flexible pipe hoses (braided reinforced)

DIVISION 16 - ELECTRICAL

A. QUALITY ASSURANCE
   1. The following documents of the issue in effect on the date the Contract is let, form a part of this Specification to the extent specified.
      a. NEC - National Electrical Code
      b. UL - Underwriters Laboratories, Inc.
      c. NEMA - National Electric Manufacturers Association
      d. IEEE - Institute of Electrical and Electronics Engineers
B. PROJECT INCLUDES
   1. Metal Conduit and Tubing:
      a. Rigid Steel Conduit: ANSI C80.1.
      b. Electrical Metallic Tubing (EMT) and Fittings: ANSI C80.3.
      c. Flexible Metal Conduit: UL 1 zinc-coated steel.
   2. Nonmetallic Conduit and Ducts:
      a. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651.
   3. Raceway Accessory Materials:
      a. Conduit Bodies and Wireways: NEC requirements.
      b. Surface Raceways, Metallic and Nonmetallic.
   4. Cable Trays:
      a. Materials: Hot-dip galvanized steel.
   5. Boxes and Fittings:
      a. Cabinet, Pull and Junction Boxes: UL 50, steel, NEMA 12.
   6. Underground Duct Applications:
      a. Electrical, Telephone and Communications: Plastic utilities duct encased in concrete.
   7. Underground Conduit and Duct:
      a. Rigid Steel or Plastic Conduit: ANSI C80.1, galvanized.
   8. Pull Boxes and Handholes
      a. Cast Metal Boxes and Fiberglass Handholes: Weatherproof cover with nonskid finish.

9. Precast Concrete Utility Structures:
    a. Precast Units: Interlocking, mating sections, ASTM C 858 and ASTM C 857.
10. Underground Raceway System Accessories:
    a. Rigid PVC duct supports with cast iron frames and covers.
11. Wire Components:
    a. Conductors for Power and Lighting Circuits: Solid conductors for No. 10 AWG and smaller; stranded conductors for No. 8 AWG and larger.
    b. Conductor Material: Copper.
    c. Insulation: XHHW for conductors size #2 and larger; THWN insulation for all other sizes.
    d. Metallic sheathed insulation for EMI/RFI reduction.
12. Cables:
    a. Armored cable for gypsum board partitions, and lighting fixture connections, sheathed cable for lighting wiring.
    b. Underground service entrance cable.
    c. Control/signal transmission media.
    d. Shielded cable for EMI/RFI reduction.
13. Connectors:
    a. UL listed.
14. Wiring Devices and Components:
    a. Receptacles.
    b. Ground-Fault Interrupter (GFI) Receptacles.
    c. Plugs and Plug Connectors: 20 amp.
    d. Telephone Jacks: 8 position 4 position modular.
15. Service Entrance:
    a. Molded-case circuit breakers, time-delay fuse and heavy-duty switches.
16. Switchboards:
    a. Switchboard: Front-connected, front-accessible NEMA 12, indoor enclosure.
    b. Utility Metering Compartment, buses and connections, and overcurrent protective devices (OCPDs).
17. Grounding:
    a. Grounding Equipment: UL 467, copper conductors and copper clad steel ground rods.

   b. Provide additional ground circuits for EMI/RFI reduction where specified.
   c. Provide Groundfault detectors where specified for EMI/RFI reduction.
18. Transformers:
   a. Dry Type, NEMA ST 20.
   b. Voltage Regulating Type, ANSI/IEEE C57.15.
19. Panelboards:
   a. Panelboards: NEMA PB 1, UL 50, 61, with overcurrent protective devices.
20. Overcurrent Protective Devices:
   a. Overcurrent Protective Devices: Integral to panelboards, switchboards, and motor control centers, with cartridge fuses, NEMA FU 1, fusible switches, UL98, NEMA KS 1.
   b. Fused Power Circuit Devices: UL 977.
   c. Molded Case Circuit Breakers: UL 489, NEMA AB 1.
21. Fuses:
   a. Cartridge Fuses: ANSI/IEEE FU 1.
22. Motor Controllers:
   a. Manual Motor Controllers; Quick-make, quick-break toggle action, Magnetic Motor Controllers; Full-voltage non reversing, across-the-line, magnetic controller, and Multispeed Motor Controllers; Full-voltage non reversing.
23. Emergency Lighting:
   a. In accordance with NFPA 101, Section 32-8.
24. Standby Power:
   a. In accordance with NFPA 101, Section 32-8.
   b. Connected to emergency lighting, fire alarm, fire pump, central control station equipment and lighting and one elevator (transferable).
25. Central Control Station:
   a. In accordance with NFPA 101, Section 32-8, located as approved by fire department.
26. Interior Lighting Components:
   a. Fluorescent Fixtures: Fixtures, UL 1570.
   b. Exit Signs: UL 924, self-powered battery type and self-powered luminous source type.

27. Exterior Lighting:
    a. High Intensity Discharge (HID) Fixtures.
28. Illumination Levels:
    a. Public Areas: 30 footcandles
    b. Offices and work areas: 50 footcandles
    c. Storage: 10 footcandles
    d. Mechanical Equip. Rooms: 10 footcandles
    e. Outside parking areas: 5 footcandles
28. Electromagnetic or Radiofrequency Interference Reduction (EMI/RFI):
    a. Provide field not to exceed 3mG in specified lab areas utilizing: Strategic placement of electrical equipment as detailed on drawings; strategic routing of cabling, use of EMT conduit with compression fittings on feeders and cabling; twist branch circuit conductors in labs; install 6mm aluminum alloy backer-plate shield on panel-boards and behind transformers and other electrical devices as indicated.
    b. Install RF shielding fabric where indicated on drawings utilizing Saf'N 'Shield as manufactured by International Paper or approved equivalent at dB attenuation rating specified.

PROJECT COST ESTIMATE

7

SECTION 7. PROJECT COST ESTIMATE

A. BASIS OF ESTIMATE

1. Cost estimates were prepared based on analysis of associated costs with tasks identified on the Work Breakdown Structure (WBS) and are as follows:

   a. WBS 1.1 Project Support

      1) Costs for BNL Project Management for technical and conventional construction were calculated as a level of effort (FTE's) of engineering and construction costs based on past experience.

      2) Costs for Project Engineering include all engineering, design and inspection. These costs were estimated by work breakdown structure tasks based on engineering assessment of factors, such as, task level of complexity, quantity of drawings, existing field conditions and availability of information detailing existing conditions.

   b. WBS 1.2 Technical Construction

      The labor hours were estimated by type of labor to be used, such as physicist, computer analyst, technician, central shops, electricians, etc. Material estimates were developed in the same manner with the cognizant individuals specifying whether their estimate was either a catalog price, vendor quote or engineering estimate. At the same time the individuals establish a contingency factor which was based on the level of detail supporting their estimate and the difficulty of the design. The hours, materials dollars and contingency factor were entered into an in-house developed Excel program that used established labor rates to calculate the costs in FY 2002 dollars. Utilizing Department of Energy economic escalation indices and calculating for a five year program with a FY 2004 start the cost estimate was then escalated to "at year dollars."

c. WBS 1.3 Conventional Construction

For Conventional Construction estimates the following methods were utilized:

1) Material quantities were derived from drawings and field measurements.

2) Installation labor wages were union crew rates, comprised of direct wages, fringe benefits, taxes and insurance and were derived from the R. S. Means Estimating Guide.

3) Direct costs for lump sum construction contracts were derived from R. S. Means Estimating Guide and a review of existing contracts and include contractors expenses for superintendent, field office, profit, insurance, taxes, bonds, office expenses, temporary construction, small tools, and overtime for shutdowns, tie-ins, and other items requiring work beyond normal working hours.

4) Prime Contractor Mark-up:
Calculated at 7.5% of direct costs assuming all contracts are managed by a general contractor.

d. WBS 1.4 Standard Equipment

For Standard Equipment estimates the following methods were utilized:

1) Material quantities were derived from drawings.

2) Installation labor wages were union crew rates, comprised of direct wages, fringe benefits, taxes and insurance and were derived from the R. S. Means Estimating Guide, catalogs, and GSA pricing.

3) Prime Contractor Mark-up:
Calculated at 7.5% of direct costs of Standard Equipment including office furniture. If BNL purchased Standard Equipment such as office computers, there would be no mark-up.

2. Contingency is estimated at WBS level 3 based on engineering assessment of risks associated with cost estimates due to unforeseen job conditions, uncertainties of market conditions for labor and materials and level of design. Contingency was generated from the lowest WBS level and carried up to the top level WBS (please see page 7-10 Contingency Table). The Contingency rate, prior to the application of burden, was 19.5%. Since the full burden rate is applied to all contingency, the overall Contingency was calculated at 20.8%. See Figure 7-1 for contingency analysis and application.

3. The DOE Cost Estimating Guide, Volume 6, dated March 1997 was used as a guide by providing uniform cost estimating methods as well as consistent estimate terminology. This guide also served as a resource tool in developing Engineering, Project Management and contingency costs.

4. The At-Year dollars are calculated by applying the escalation rates to the project forecasted annual expenditures. Rates are taken from the DOE Escalation Rate Assumptions for DOE Projects Guidance, January 2002 Update.

Escalation Rates:

a.	2003	2.1%
b.	2004	2.5%
c.	2005	2.9%
d.	2006	2.8%
e.	2007	2.6%
f.	2008	2.6%

5. The Application of Burden is calculated using the current Fiscal Year BNL Extraordinary Construction Project General & Administrative (G&A) Rate of 14.0% for FY 2003 but can vary from year to year. This rate, which is broken down into Traditional G&A of 5.3% and Common Support of 8.7%, is applied to the total modified costs (direct labor, material cost less special procurements, and burdens). All trade labor is charged using the common support rate of 8.7%. All special procurements are charged using the traditional G&A of 5.3%. This project assumes that approximately 80% of all material purchases will be special procurements. A material burden rate of 6.5% is charged to all material purchases. There is one exception to the material burden and the G&A burden. BNL has a cap on extraordinary procurements (a material purchase of greater than $600,000 in a single procurement action). In that case material burden and G&A are applied to the first $600,000 of that purchase and no material burden nor G&A on any amount over the $600,000. All change orders to procurement contracts that utilize contingency funds will be charged the full burden rate.

B. OPERATING FUNDS

Once construction has been completed on this project, the CFN Department will be requesting from DOE BES an Operating Budget of $20 million to operate and staff the new building and utilize the new Laboratory equipment. The staff will consist of senior scientist, junior scientists, technicians and engineers, post docs and students. University and Industry visitors, and administrative employees. There will be about 70 employees and over 40 post docs and students funded by this new department. These funds will allow the CFN Department to develop new technologies in nanoscience research, and thereby expand our capabilities to maintain and develop a larger user base.

C. REFERENCES

1. The Detailed Direct Cost Estimate was compiled using the following sources:

a. R. S. Means Estimating Guide, 2002.
b. Brookhaven National Laboratory work experience.

2. The legend for the Detailed Direct Cost Estimate is as follows:
   a. CY - Cubic Yard
   b. EA - Each
   c. LF - Linear Foot
   d. CLF - 100 Linear Feet
   e, LS - Lump Sum
   f. SF - Square Foot
   g. T - Ton
   h. MTH - Month
   i. Da - Day
   j. MVA - million-volt-amperes
   k. VQ – Vendor Quote
   l. Cwt – 100 pounds

FIGURE 7-1

CFN Contingency Risk Summary

WBS Item	Description	Assigned Contingency	Risk Assessment Technical	Risk Assessment Cost	Risk Assessment Schedule	Impact Assessment Technical	Impact Assessment Cost	Impact Assessment Schedule	Comments/Rationale
1.1	**Project Support**								
1.1.1	Project Management	15.0%	Low	Low	Moderate	Moderate	Moderate	Moderate	Greatest risk is failure to maintain project schedule due to funding delays & added review requirements. Although liklihood is low, scope growth could affect technical and cost objectives
1.1.2	Project Engineering	10.9%	Moderate	Low	Low	Moderate	Moderate	Low	Moderate technical risks due to some custom instrumentation and special construction requirements. These could impact costs if not properly executed.
1.2	**Technical Construction**								
1.2.1	Nanopatterning	25.0%	Moderate	Low	Moderate	Moderate	Low	Moderate	Dependent on clean room performance however uses off-the - shelf equipment. Equipment is very long lead with moderate schedule risk
1.2.2	Ultrafast Optical Sources	20.0%	Low	Low	Low	Low	Low	Low	Numerous off the shelf small procurements, some assembly and customization but has been done previously.
1.2.3	Electron Microscopy	25.0%	Moderate	Low	Moderate	Moderate	Low	Moderate	Large, costly, longlead (built to spec) instruments that are very sensitive to facility design & construction quality (vibration, EMI/RFI, temp control)
1.2.4	Materials Systhesis	25.0%	Moderate	Low	Low	Moderate	Low	Low	Numerous off the shelf small procurements, requires isolated clean room and good environmental controls.
1.2.5	Proximal Probes	25.0%	Moderate	Low	Low	Moderate	Low	Low	Numerous off the shelf small procurements, requires good vibration and environmental controls
1.2.6	Theory & Computation	20.0%	Low	Low	Low	Low	Low	Low	Requires readily available computer equipment and specialized software. Computers are very low risk balanced by slight software development risk.
1.2.7	CFN Endstations At NSLS	20.0%	Low	Low	Low	Low	Low	Low	Requires endstation equipment previously designed and fabricated at BNL.
1.3	**Conventional Construction**								
1.3.1	Improvements to Land	9.0%	Low	Low	Low	Low	Moderate	Moderate	Although unlikely, discovery of unexpected contamination could have moderate cost and schedule impacts.
1.3.2	Building	17.5%	Moderate	Moderate	Low	Moderate	Moderate	Low	Although largely standard construction, special construction for vibration isolation, low EMI/RFI and tight environmental control increase technical & cost risks and impacts.
1.3.3	Utilities	15.0%	Low	Moderate	Moderate	Low	Moderate	Moderate	In addition to inherent risks of underground excavation, relocation of storm drainage system in this area bears moderate risk to cost & schedule
1.4	**Standard Equipment**	5.0%	Low	Low	Low	Low	Low	Low	Standard equipment is inherently low risk due to off-the-shelf availability and catalog/GSA pricing.

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

1/13/2003

PROJECT DATA SHEET RECONCILIATION - FY2004 START

10. Details of Cost Estimate	WBS NO.	FY 02 K$	AY K$	INDIRECT COSTS	RND'NG	PDS AY K$
Design Phase		4,007	4,250	610		4,860
Preliminary & Final Design Costs	1.1.2.1	3,171	3,367	485		3,852
Project Management	1.1.1.1	836	883	124		1,008
						0
Construction Phase		55,524	61,664	3,864		65,528
Technical Facilities		28,594	31,793	3,413		35,205
Nanopatterning	1.2.1	6,669	7,309	482		7,791
Ultrafast Optical Sources	1.2.2	2,842	3,210	457		3,666
Electron Microscopy	1.2.3	7,856	8,770	691		9,461
Materials Synthesis	1.2.4	3,466	3,876	552		4,428
Proximal Probes	1.2.5	4,944	5,501	787		6,288
Theory & Computation	1.2.6	488	549	79		627
CFN Endstations at NSLS	1.2.7	930	1,036	150		1,186
Inspection, design, liaison, test, accepta	1.1.2.2.1	524	571	80		651
Project Management	1.1.1.2.1	874	971	136		1,107
Conventional Facilities		26,930	29,871	451		30,323
Improvements to land	1.3.1	801	889	0		889
Buildings	1.3.2	20,469	22,712	76		22,788
Utilities	1.3.3	3,326	3,659	0		3,659
Standard equipment	1.4	1,010	1,151	166		1,317
Inspection, design, liaison, test, accepta	1.1.2.2.2	758	837	121		958
Project Management	1.1.1.2.2	566	624	88		711
Sub-total	-	59,531	65,914	4,474		70,388
Contingencies	-	11,617	12,878	1,730	5	14,612
Total Line item cost	-	71,148	78,792	6,203	5	85,000
Non-Federal Contribution	-	0	0	0		0
Net Federal Total Estimated Cost (TEC)	-	**71,148**	**78,792**	**6,203**	**5**	**85,000**

BNL CENTER FOR FUNCTIONAL NANOMATERIALS
COST ESTIMATE IN AT YEAR DOLLARS
APPLICATION OF BURDEN
(DOLLARS X1000)

WBS NO.	DESCRIPTION	FY 2004 START — FISCAL YEAR 2004	2005	2006	2007	2008	TOTAL
1.1	PROJECT SUPPORT	3,415	1,931	1,246	571	90	7,253
	CONTINGENCY @ 12.3%	420	237	153	70	11	892
	TOTAL	3,835	2,169	1,399	641	101	8,145
1.2	TECHNICAL CONSTRUCTION	0	6,044	18,906	4,892	409	30,250
	CONTINGENCY @ 24.2%	0	1,464	4,578	1,185	99	7,326
	TOTAL	0	7,507	23,484	6,076	508	37,576
1.3	CONVENTIONAL CONSTRUCTION	0	9,852	12,676	4,731	0	27,260
	CONTINGENCY @ 16.9%	0	1,664	2,140	799	0	4,603
	TOTAL	0	11,516	14,816	5,530	0	31,863
1.4	STANDARD EQUIPMENT	0	0	0	1,151	0	1,151
	CONTINGENCY @ 5.0%	0	0	0	58	0	58
	TOTAL	0	0	0	1,209	0	1,209
	SUB-TOTAL	3,415	17,827	32,828	11,345	499	65,914
	CONTINGENCY @ AVG 19.5%	420	3,365	6,872	2,111	110	12,878
	TOTAL PROJECT AY DIRECT K$	3,835	21,192	39,700	13,456	609	78,792

	2004	2005	2006	2007	2008	TOTAL
BNL INDIRECT CALCULATION (BASED ON COST):						
TOTAL PROJECT COST (W/O CONTINGENCY)	2,333	12,073	26,994	20,077	4,437	65,914
LESS MATERIAL COMPONENT	(1,579)	(11,075)	(25,402)	(18,443)	(4,024)	(60,524)
BALANCE = LABOR COMPONENT	754	998	1,592	1,634	412	5,390
LESS TRADE LABOR	0	(19)	(89)	(202)	0	(311)
DIRECT PROJECT LABOR	754	979	1,503	1,431	412	5,079
ADD CONTINGENCY OF 19.5%	147	191	294	280	81	992
A) DIRECT PROJECT LABOR + CONTINGENCY	902	1,170	1,796	1,711	493	6,072
TRADE LABOR	0	19	89	202	0	311
ADD CONTINGENCY OF 19.5%	0	4	17	40	0	61
B) TRADE LABOR + CONTINGENCY	0	23	106	242	0	371
C) LARGE COMPONENTS (OVER 600K)	0	8,550	16,037	9,754	1,918	36,260
D) ADD CONTINGENCY OF 19.5%	0	1,671	3,133	1,906	375	7,084
DIRECT LARGE COMPONENTS + CONTINGENCY	0	10,221	19,170	11,660	2,293	43,344
MATERIAL COMPONENT	1,579	2,525	9,366	8,689	2,106	24,264
ADD CONTINGENCY OF 19.5%	308	493	1,830	1,698	411	4,740
E) DIRECT MATERIAL + CONTINGENCY	1,887	3,018	11,196	10,386	2,517	29,005
INDIRECT CALCULATIONS:						
F) MATERIAL BURDEN RATE @ 6.5% (D+E+First 600K of C)	123	344	970	838	188	2,463
BNL G&A ON LARGE COMPONENTS @ 5.3% (First 600K of C)	0	32	32	32	0	95
BNL G&A @ 14.0% (A+[E*.2]+F)	196	297	701	648	166	2,008
BNL COMMON SUPPORT @ 8.7% (B)	0	2	9	21	0	32
BNL G&A ON SUBCONTRACTS @ 5.3% (D+[E*.8])	80	216	641	541	127	1,605
ROUNDING:	12	(23)	(21)	21	16	5
TOTAL COSTS IN AYK$ INCLUDING BURDENS & G&A:	**$3,200**	**$15,300**	**$34,600**	**$26,100**	**$5,800**	**$85,000**
TOTAL FUNDING REQUIRED IN AYK$:	**$4,100**	**$22,900**	**$42,800**	**$15,200**	**$0**	**$85,000**

NOTE: Indirect rates are subject to change each Fiscal Year.

WBS IN AT-YEAR DOLLAR CALCULATIONS
BNL CENTER FOR FUNCTIONAL NANOMATERIALS
COST ESTIMATE IN AT YEAR DOLLARS
(FY 2004 START)

WBS LEVEL	DESCRIPTION	LVL 5	LVL 4	LVL 3	LVL 2	LVL 1
1.0	CENTER FOR FUNCTIONAL NANOMATERIALS					65,914
	CONTINGENCY @ 19.5% OF WBS #1.0					12,878
1.1	PROJECT SUPPORT				7,253	
1.1.1	PROJECT MGT.			2,478		
1.1.1.1	PROJECT MGT. - DESIGN PHASE		883			
1.1.1.1.1	PM - TECHNICAL DESIGN	448				
1.1.1.1.2	PM - CONVENTIONAL DESIGN	435				
1.1.1.2	PROJECT MGT. - CONSTRUCTION PHASE		1,595			
1.1.1.2.1	PM - TECHNICAL CONSTRUCTION	971				
1.1.1.2.2	PM - CONVENTIONAL CONSTRUCTION	624				
1.1.2	PROJECT ENGRG.			4,776		
1.1.2.1	PROJECT ENGINEERING - DESIGN PHASE		3,367			
1.1.2.1.1	PE - TECHNICAL DESIGN	347				
1.1.2.1.2	PE - CONVENTIONAL DESIGN	3,020				
1.1.2.2	PROJECT ENGINEERING - CONSTRUCTION PHASE		1,408			
1.1.2.2.1	PE - TECHNICAL CONSTRUCTION	571				
1.1.2.2.2	PE - CONVENTIONAL CONSTRUCTION	837				
	CONTINGENCY @ 12.3% OF WBS #1.1				892	
1.2	TECHNICAL CONSTRUCTION				30,250	
1.2.1	NANOPATTERNING			7,309		
1.2.2	ULTRAFAST OPTICAL SOURCES			3,210		
1.2.3	ELECTRON MICROSCOPY			8,770		
1.2.4	MATERIALS SYNTHESIS			3,876		
1.2.5	PROXIMAL PROBES			5,501		
1.2.6	THEORY & COMPUTATION			549		
1.2.7	CFN ENDSTATIONS AT NSLS			1,036		
	CONTINGENCY @ 24.2% OF WBS #1.2				7,326	
1.3	CONVENTIONAL CONSTRUCTION				27,260	
1.3.1	IMPROVEMENTS TO LAND			889		
1.3.2	BUILDINGS			22,712		
1.3.3	UTILITIES			3,659		
	CONTINGENCY @ 16.9% OF WBS #1.3				4,603	
1.4	STANDARD EQUIPMENT				1,151	
	CONTINGENCY @ 5.0% OF WBS #1.4				58	

* Excludes BNL overhead (G&A).

WBS IN FY 2002 DOLLAR CALCULATIONS
BNL CENTER FOR FUNCTIONAL NANOMATERIALS
COST ESTIMATE IN FY 2002 DOLLARS
(FY 2004 START)

WBS LEVEL	DESCRIPTION	LVL 5	LVL 4	LVL 3	LVL 2	LVL 1
1.0	CENTER FOR FUNCTIONAL NANOMATERIALS					59,531
	CONTINGENCY @ 19.5% OF WBS #1.0					11,617
1.1	PROJECT SUPPORT				6,729	
1.1.1	PROJECT MGT.			2,277		
1.1.1.1	PROJECT MGT. - DESIGN PHASE		836			
1.1.1.1.1	PM - TECHNICAL DESIGN	425				
1.1.1.1.2	PM - CONVENTIONAL DESIGN	411				
1.1.1.2	PROJECT MGT. - CONSTRUCTION PHASE		1,440			
1.1.1.2.1	PM - TECHNICAL CONSTRUCTION	874				
1.1.1.2.2	PM - CONVENTIONAL CONSTRUCTION	566				
1.1.2	PROJECT ENGRG.			4,453		
1.1.2.1	PROJECT ENGINEERING - DESIGN PHASE		3,171			
1.1.2.1.1	PE - TECHNICAL DESIGN	328				
1.1.2.1.2	PE - CONVENTIONAL DESIGN	2,843				
1.1.2.2	PROJECT ENGINEERING - CONSTRUCTION PHASE		1,282			
1.1.2.2.1	PE - TECHNICAL CONSTRUCTION	524				
1.1.2.2.2	PE - CONVENTIONAL CONSTRUCTION	758				
	CONTINGENCY @ 12.3% OF WBS #1.1				827	
1.2	TECHNICAL CONSTRUCTION				27,195	
1.2.1	NANOPATTERNING			6,669		
1.2.2	ULTRAFAST OPTICAL SOURCES			2,842		
1.2.3	ELECTRON MICROSCOPY			7,856		
1.2.4	MATERIALS SYNTHESIS			3,466		
1.2.5	PROXIMAL PROBES			4,944		
1.2.6	THEORY & COMPUTATION			488		
1.2.7	CFN ENDSTATIONS AT NSLS			930		
	CONTINGENCY @ 24.2% OF WBS #1.2				6,586	
1.3	CONVENTIONAL CONSTRUCTION				24,596	
1.3.1	IMPROVEMENTS TO LAND			801		
1.3.2	BUILDINGS			20,469		
1.3.3	UTILITIES			3,326		
	CONTINGENCY @ 16.9% OF WBS #1.3				4,153	
1.4	STANDARD EQUIPMENT				1,010	
	CONTINGENCY @ 5.0% OF WBS #1.4				50	

* Excludes BNL overhead (G&A).

BNL CENTER FOR FUNCTIONAL NANOMATERIALS
CONTINGENCY TABLE

FY 2004 START

WBS #	DESCRIPTION	LEVEL 3			LEVEL 2			LEVEL 1		
		%	02K$	AYK$	%	02K$	AYK$	%	02K$	AYK$
1.0	CENTER FOR FUNCTIONAL NANOMATERIALS							19.5%	11,617	12,878
1.1	PROJECT SUPPORT				12.3%	827	892			
1.1.1	PROJECT MGT.	15.0%	341	371						
1.1.2	PROJECT ENGINEERING	10.9%	486	521						
1.2	TECHNICAL CONSTRUCTION				24.2%	6,586	7,326			
1.2.1	NANOPATTERNING	25.0%	1,667	1,828						
1.2.2	ULTRAFAST OPTICAL SOURCES	20.0%	568	642						
1.2.3	ELECTRON MICROSCOPY	25.0%	1,964	2,194						
1.2.4	MATERIALS SYNTHESIS	25.0%	867	970						
1.2.5	PROXIMAL PROBES	25.0%	1,236	1,375						
1.2.6	THEORY & COMPUTATION	20.0%	98	110						
1.2.7	CFN ENDSTATIONS AT NSLS	20.0%	186	207						
1.3	CONVENTIONAL CONSTRUCTION				16.9%	4,153	4,603			
1.3.1	IMPROVEMENTS TO LAND	9.0%	72	80						
1.3.2	BUILDINGS	17.5%	3,582	3,974						
1.3.3	UTILITIES	15.0%	499	549						
1.4	STANDARD EQUIPMENT				5.0%	50	58			

BNL CENTER FOR FUNCTIONAL NANOMATERIALS
NUMBER OF FULL TIME EQUAVALENT (FTE) BY CLASSIFICATION

WBS NAME: Summary of Center for Functional Nanomaterials

WBS NO: 1.0

CLASSIFICATION	FISCAL YEAR 2004	2005	2006	2007	2008	TOTAL
PHYSICIST	2.38	2.38	5.25	6.00	1.50	17.50
ELECT ENGR	0.00	0.63	0.63	0.00	0.00	1.25
MECH ENGR	0.00	0.63	0.63	0.00	0.00	1.25
COMP. ANALYST	0.13	0.13	0.75	1.00	0.25	2.25
DESIGN - ELECT	0.00	0.50	0.25	0.00	0.00	0.75
DESIGN - MECH	0.00	0.50	0.25	0.00	0.00	0.75
ADMIN	2.25	1.75	1.75	1.75	0.50	8.00
CONSTR. MGMT	2.00	2.00	2.00	0.50	0.00	6.50
TECH - VACUUM	0.00	0.00	0.50	1.00	0.50	2.00
TECH - ELECT	0.00	0.00	0.00	0.50	0.25	0.75
TECH - MECH	0.00	0.00	0.50	1.25	0.50	2.25
TOTAL FTE's	6.75	8.50	12.50	12.00	3.50	**43.25**

J. DETAIL COST ESTIMATE

WBS NO 1 **Center for Functional Nanomaterials** TOTAL COST AND OBLIGATION

		TOTAL	2004	2005	2006	2007	2008
TOTAL LABOR AY$		5,390	754	998	1,592	1,634	412
TOTAL MSTC AY$	COST	60,524	1,579	11,075	25,402	18,443	4,024
	OBLIGATION	60,524	2,661	16,829	31,236	9,711	87
TOTAL COST AY$		65,914	2,333	12,073	26,994	20,077	4,437
TOTAL OBLIGATION AY$		65,914	3,415	17,827	32,828	11,345	499

NOTE: MSTC AY$ include both escallation and material shift.

1.0	**BNL Center for Functional Nanomaterials**	Contngy %	Contngy 2002$	Contngy AY$
1.1	PROJECT SUPPORT	12.3%	827	892
1.2	TECHNICAL CONSTRUCTION	24.2%	6,586	7,326
1.3	CONVENTIONAL CONSTRUCTION	16.9%	4,153	4,603
1.4	STANDARD EQUIPMENT	5.0%	50	58
1.5		0.0%	0	0
1.6		0.0%	0	0
1.7		0.0%	0	0
1.8		0.0%	0	0
1.9		0.0%	0	0
1.10		0.0%	0	0
		19.5%	11,617	12,878

WBS NAME: **BNL Center for Functional Nanomaterials** SUMMARY ESTIMATES IN 1000$

WBS NO. 1.0

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.1	PROJECT SUPPORT	**2,803**	**3,926**	**6,729**	3,235	1,787	1,126	504	78
1.2	TECHNICAL CONSTRUCTION	**2,091**	**25,104**	**27,195**	0	5,561	16,978	4,301	354
1.3	CONVENTIONAL CONSTRUCTION	**0**	**24,596**	**24,596**	0	9,066	11,380	4,151	0
1.4	STANDARD EQUIPMENT	**0**	**1,010**	**1,010**	0	0	0	1,010	0
1.5	0	**0**	**0**	**0**	0	0	0	0	0
1.6	0	**0**	**0**	**0**	0	0	0	0	0
1.7	0	**0**	**0**	**0**	0	0	0	0	0
1.8	0	**0**	**0**	**0**	0	0	0	0	0
1.9	0	**0**	**0**	**0**	0	0	0	0	0
1.10	0	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	**4,894**	**54,636**	**59,531**	3,235	16,414	29,484	9,966	432
WBS TOTAL	**AY$ COST**			**65,914**	2,333	12,073	26,994	20,077	4,437
	OBLIGATION			**65,914**	3,415	17,827	32,828	11,345	499

WBS NO 1.1 **PROJECT SUPPORT** TOTAL COST AND OBLIGATION

		TOTAL	2004	2005	2006	2007	2008
TOTAL LABOR AY$		3,039	754	979	852	370	84
TOTAL MSTC AY$	COST	4,214	1,579	1,647	621	279	87
	OBLIGATION	4,214	2,661	953	394	201	6
TOTAL COST AY$		7,253	2,333	2,626	1,473	649	171
TOTAL OBLIGATION AY$		7,253	3,415	1,931	1,246	571	90

NOTE: MSTC AY$ include both escallation and material shift.

1.1	**PROJECT SUPPORT**	Contngy %	Contngy 2002$
1.1.1	PROJECT MANAGEMENT	15.0%	341
1.1.2	PROJECT ENGINEERING	10.9%	486
1.1.3		0.0%	0
1.1.4		0.0%	0
1.1.5		0.0%	0
1.1.6		0.0%	0
1.1.7		0.0%	0
1.1.8		0.0%	0
1.1.9		0.0%	0
1.1.10		0.0%	0
		12.3%	827

WBS NAME: **PROJECT SUPPORT** SUMMARY ESTIMATES IN 1000$

WBS NO. 1.1

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.1.1	PROJECT MANAGEMENT	**1,952**	**325**	**2,277**	631	587	577	403	78
1.1.2	PROJECT ENGINEERING	**852**	**3,601**	**4,453**	2,604	1,199	548	101	0
1.1.3	0	**0**	**0**	**0**	0	0	0	0	0
1.1.4	0	**0**	**0**	**0**	0	0	0	0	0
1.1.5	0	**0**	**0**	**0**	0	0	0	0	0
1.1.6	0	**0**	**0**	**0**	0	0	0	0	0
1.1.7	0	**0**	**0**	**0**	0	0	0	0	0
1.1.8	0	**0**	**0**	**0**	0	0	0	0	0
1.1.9	0	**0**	**0**	**0**	0	0	0	0	0
1.1.10	0	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	**2,803**	**3,926**	**6,729**	3,235	1,787	1,126	504	78
WBS TOTAL	**AY$ COST**			**7,253**	2,333	2,626	1,473	649	171
	OBLIGATION			**7,253**	3,415	1,931	1,246	571	90

WBS NAME: **PROJECT MANAGEMENT** SUMMARY ESTIMATES

IN 1000$

WBS NO. 1.1.1

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.1.1.1	PROJECT MGMT - DESIGN PHASE	**666**	**170**	**836**	631	205	0	0	0
1.1.1.2	PROJECT MGMT - CONSTRUCTION PHASE	**1,285**	**155**	**1,440**	0	382	577	403	78
1.1.1.3	0	**0**	**0**	**0**	0	0	0	0	0
1.1.1.4	0	**0**	**0**	**0**	0	0	0	0	0
1.1.1.5	0	**0**	**0**	**0**	0	0	0	0	0
1.1.1.6	0	**0**	**0**	**0**	0	0	0	0	0
1.1.1.7	0	**0**	**0**	**0**	0	0	0	0	0
1.1.1.8	0	**0**	**0**	**0**	0	0	0	0	0
1.1.1.9	0	**0**	**0**	**0**	0	0	0	0	0
1.1.1.10	0	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	**1,952**	**325**	**2,277**	631	587	577	403	78
WBS TOTAL	**AY$ COST**			**2,478**	625	632	642	455	125
	OBLIGATION			**2,478**	661	633	638	456	90

WBS NAME: **PROJECT MANAGEMENT** MANPOWER ESTIMATE SUMMARY

IN HOURS & $1000

WBS NO. 1.1.1

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	1,760	1,760	1,760	1,760	440	**7,480**
ELECT ENGR	0	0	0	0	0	**0**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
DESIGN - ELECT	0	0	0	0	0	**0**
DESIGN - MECH	0	0	0	0	0	**0**
ADMIN	3,960	3,080	3,080	3,080	880	**14,080**
CONSTR. MGMT	3,520	3,520	3,520	880	0	**11,440**
TOT.S&P MANPOWER	5,280	5,280	5,280	2,640	440	**18,920**
TOT.OTHER MP	3,960	3,080	3,080	3,080	880	**14,080**
TOTAL MANPOWER	9,240	8,360	8,360	5,720	1,320	**33,000**
S&P DOLLARS	350	350	350	175	29	**1,252**
OTHER DOLLARS	197	153	153	153	44	**699**
TOTAL LABOR 2002$	546	502	502	328	73	**1,952**
Material 2002$	85.0	85.0	75.0	75.0	5.0	**325.0**

WBS NAME: **PROJECT MGMT - DESIGN PHASE** MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.1.1

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	1,760	440	0	0	0	**2,200**
ELECT ENGR	0	0	0	0	0	**0**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
DESIGN - ELECT	0	0	0	0	0	**0**
DESIGN - MECH	0	0	0	0	0	**0**
ADMIN	3,960	660	0	0	0	**4,620**
CONSTR. MGMT	3,520	880	0	0	0	**4,400**
						0
						0
TOT.S&P MANPOWER	5,280	1,320	0	0	0	**6,600**
TOT.OTHER MP	3,960	660	0	0	0	**4,620**
TOTAL MANPOWER	9,240	1,980	0	0	0	**11,220**
S&P DOLLARS	350	87	0	0	0	**437**
OTHER DOLLARS	197	33	0	0	0	**229**
TOTAL LABOR 2002$	546	120	0	0	0	**666**
Material 2002$	85.0	85.0	0.0	0.0	0.0	**170.0**

WBS NAME: **PROJECT MGMT - CONSTRUCTION PHASE**
MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.1.2

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	1,320	1,760	1,760	440	**5,280**
ELECT ENGR	0	0	0	0	0	**0**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
DESIGN - ELECT	0	0	0	0	0	**0**
DESIGN - MECH	0	0	0	0	0	**0**
ADMIN	0	2,420	3,080	3,080	880	**9,460**
CONSTR. MGMT	0	2,640	3,520	880	0	**7,040**
						0
						0
TOT.S&P MANPOWER	0	3,960	5,280	2,640	440	**12,320**
TOT.OTHER MP	0	2,420	3,080	3,080	880	**9,460**
TOTAL MANPOWER	0	6,380	8,360	5,720	1,320	**21,780**
S&P DOLLARS	0	262	350	175	29	**816**
OTHER DOLLARS	0	120	153	153	44	**470**
TOTAL LABOR 2002$	0	382	502	328	73	**1,285**
Material 2002$	0.0	0.0	75.0	75.0	5.0	**155.0**

WBS NAME: **PROJECT ENGINEERING** SUMMARY ESTIMATES
IN 1000$

WBS NO. 1.1.2

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.1.2.1	PROJECT ENGRG - DESIGN PHASE	**328**	**2,843**	**3,171**	2,604	566	0	0	0
1.1.2.2	PROJECT ENGRG - CONSTRUCTION PHASE	**524**	**758**	**1,282**	0	633	548	101	0
1.1.2.3	0.00	**0**	**0**	**0**	0	0	0	0	0
1.1.2.4	0.00	**0**	**0**	**0**	0	0	0	0	0
1.1.2.5	0.00	**0**	**0**	**0**	0	0	0	0	0
1.1.2.6	0.00	**0**	**0**	**0**	0	0	0	0	0
1.1.2.7	0.00	**0**	**0**	**0**	0	0	0	0	0
1.1.2.8	0.00	**0**	**0**	**0**	0	0	0	0	0
1.1.2.9	0.00	**0**	**0**	**0**	0	0	0	0	0
1.1.2.10	0.00	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	**852**	**3,601**	**4,453**	2,604	1,199	548	101	0
WBS TOTAL	**AY$ COST**			**4,776**	1,708	1,994	831	195	47
	OBLIGATION			**4,776**	2,754	1,299	608	115	0

WBS NAME: **PROJECT ENGINEERING** MANPOWER ESTIMATE SUMMARY
IN HOURS & $1000

WBS NO. 1.1.2

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	2,420	2,420	1,210	0	0	**6,050**
ELECT ENGR	0	1,100	1,100	0	0	**2,200**
MECH ENGR	0	1,100	1,100	0	0	**2,200**
COMPUTER ANALYST	220	220	0	0	0	**440**
DESIGN - ELECT	0	880	440	0	0	**1,320**
DESIGN - MECH	0	880	440	0	0	**1,320**
ADMIN	0	0	0	0	0	**0**
CONSTR. MGMT	0	0	0	0	0	**0**
TOT.S&P MANPOWER	2,640	4,840	3,410	0	0	**10,890**
TOT.OTHER MP	0	1,760	880	0	0	**2,640**
TOTAL MANPOWER	2,640	6,600	4,290	0	0	**13,530**
S&P DOLLARS	174.8	320.4	225.7	0.0	0.0	**720.9**
OTHER DOLLARS	0.0	87.4	43.7	0.0	0.0	**131.1**
TOTAL LABOR 2002$	174.8	407.8	269.4	0.0	0.0	**852.0**
Material 2002$	2,429.4	791.5	278.9	101.2	0.0	**3,601.0**

WBS NAME: **PROJECT ENGRG - DESIGN PHASE** MANPOWER ESTIMATES

IN HOURS & $1000

WBS NO. 1.1.2.1

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	2,420	1,210	0	0	0	**3,630**
ELECT ENGR	0	0	0	0	0	**0**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	220	110	0	0	0	**330**
DESIGN - ELECT	0	660	0	0	0	**660**
DESIGN - MECH	0	660	0	0	0	**660**
ADMIN	0	0	0	0	0	**0**
CONSTR. MGMT	0	0	0	0	0	**0**
						0
						0
TOT.S&P MANPOWER	2,640	1,320	0	0	0	**3,960**
TOT.OTHER MP	0	1,320	0	0	0	**1,320**
TOTAL MANPOWER	2,640	2,640	0	0	0	**5,280**
S&P DOLLARS	174.8	87.4	0.0	0.0	0.0	**262.1**
OTHER DOLLARS	0.0	65.5	0.0	0.0	0.0	**65.5**
TOTAL LABOR 2002$	174.8	152.9	0.0	0.0	0.0	**327.7**
Material 2002$	2,429.4	413.5	0.0	0.0	0.0	**2,842.9**

WBS NAME: **PROJECT ENGRG - CONSTRUCTION PHASE**

MANPOWER ESTIMATES

IN HOURS & $1000

WBS NO. 1.1.2.2

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	1,210	1,210	0	0	**2,420**
ELECT ENGR	0	1,100	1,100	0	0	**2,200**
MECH ENGR	0	1,100	1,100	0	0	**2,200**
COMPUTER ANALYST	0	110	0	0	0	**110**
DESIGN - ELECT	0	220	440	0	0	**660**
DESIGN - MECH	0	220	440	0	0	**660**
ADMIN	0	0	0	0	0	**0**
CONSTR. MGMT	0	0	0	0	0	**0**
						0
						0
TOT.S&P MANPOWER	0	3,520	3,410	0	0	**6,930**
TOT.OTHER MP	0	440	880	0	0	**1,320**
TOTAL MANPOWER	0	3,960	4,290	0	0	**8,250**
S&P DOLLARS	0.0	233.0	225.7	0.0	0.0	**458.8**
OTHER DOLLARS	0.0	21.8	43.7	0.0	0.0	**65.5**
TOTAL LABOR 2002$	0.0	254.9	269.4	0.0	0.0	**524.3**
Material 2002$	0.0	378.0	278.9	101.2	0.0	**758.1**

WBS NAME: **PROJECT ENGRG - DESIGN PHASE** SUMMARY ESTIMATES
IN 1000$

WBS NO. 1.1.2.1

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.1.2.1.1	PE - TECHNICAL DESIGN	328	0	328	175	153	0	0	0
1.1.2.1.2	PE - CONVENTIONAL DESIGN	0	2,843	2,843	2,429	414	0	0	0
1.1.2.1.3	0.00	0	0	0	0	0	0	0	0
1.1.2.1.4	0.00	0	0	0	0	0	0	0	0
1.1.2.1.5	0.00	0	0	0	0	0	0	0	0
1.1.2.1.6	0.00	0	0	0	0	0	0	0	0
1.1.2.1.7	0.00	0	0	0	0	0	0	0	0
1.1.2.1.8	0.00	0	0	0	0	0	0	0	0
1.1.2.1.9	0.00	0	0	0	0	0	0	0	0
1.1.2.1.10	0.00	0	0	0	0	0	0	0	0
WBS TOTAL	**2002$**	328	2,843	3,171	2,604	566	0	0	0
WBS TOTAL	**AY$ COST**			3,367	1,708	1,476	183	0	0
	OBLIGATION			3,367	2,754	614	0	0	0

WBS NAME: **PROJECT ENGRG - DESIGN PHASE** MANPOWER ESTIMATES SUMMARY
IN HOURS & $1000

WBS NO. 1.1.2.1

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	2,420	1,210	0	0	0	3,630
ELECT ENGR	0	0	0	0	0	0
MECH ENGR	0	0	0	0	0	0
COMPUTER ANALYST	220	110	0	0	0	330
DESIGN - ELECT	0	660	0	0	0	660
DESIGN - MECH	0	660	0	0	0	660
ADMIN	0	0	0	0	0	0
CONSTR. MGMT	0	0	0	0	0	0
TOT.S&P MANPOWER	2,640	1,320	0	0	0	3,960
TOT.OTHER MP	0	1,320	0	0	0	1,320
TOTAL MANPOWER	2,640	2,640	0	0	0	5,280
S&P DOLLARS	174.8	87.4	0.0	0.0	0.0	262.1
OTHER DOLLARS	0.0	65.5	0.0	0.0	0.0	65.5
TOTAL LABOR 2002$	174.8	152.9	0.0	0.0	0.0	327.7
Material 2002$	2,429.4	413.5	0.0	0.0	0.0	2,842.9

WBS NAME: **PE - TECHNICAL DESIGN**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.1.1

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	2,420	1,210	0	0	0	3,630
ELECT ENGR	0	0	0	0	0	0
MECH ENGR	0	0	0	0	0	0
COMPUTER ANALYST	220	110	0	0	0	330
DESIGN - ELECT	0	660	0	0	0	660
DESIGN - MECH	0	660	0	0	0	660
ADMIN	0	0	0	0	0	0
CONSTR. MGMT	0	0	0	0	0	0
						0
						0
TOT.S&P MANPOWER	2,640	1,320	0	0	0	3,960
TOT.OTHER MP	0	1,320	0	0	0	1,320
TOTAL MANPOWER	2,640	2,640	0	0	0	5,280
S&P DOLLARS	174.8	87.4	0.0	0.0	0.0	262.1
OTHER DOLLARS	0.0	65.5	0.0	0.0	0.0	65.5
TOTAL LABOR 2002$	174.8	152.9	0.0	0.0	0.0	327.7
Material 2002$						0.0

WBS NAME: **PE - CONVENTIONAL DESIGN**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.1.2

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	0	0	0	0
ELECT ENGR	0	0	0	0	0	0
MECH ENGR	0	0	0	0	0	0
COMPUTER ANALYST	0	0	0	0	0	0
DESIGN - ELECT	0	0	0	0	0	0
DESIGN - MECH	0	0	0	0	0	0
ADMIN	0	0	0	0	0	0
CONSTR. MGMT	0	0	0	0	0	0
						0
						0
TOT.S&P MANPOWER	0	0	0	0	0	0
TOT.OTHER MP	0	0	0	0	0	0
TOTAL MANPOWER	0	0	0	0	0	0
S&P DOLLARS	0.0	0.0	0.0	0.0	0.0	0.0
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL LABOR 2002$	0.0	0.0	0.0	0.0	0.0	0.0
Material 2002$	2,429.4	413.5	0.0	0.0	0.0	2,842.9

WBS NAME: **PE - TECHNICAL DESIGN** SUMMARY ESTIMATES IN 1000$

WBS NO. 1.1.2.1.1

		LABOR	MATL	TOTAL	2,004	2,005	2,006	2,007	2,008
1.1.2.1.1.1	NANOPATTERNING	66	0	66	29	36	0	0	0
1.1.2.1.1.2	ULTRAFAST OPTICAL SOURCES	66	0	66	29	36	0	0	0
1.1.2.1.1.3	ELECTRON MICROSCOPY	87	0	87	58	29	0	0	0
1.1.2.1.1.4	MATERIALS SYNTHESIS	22	0	22	15	7	0	0	0
1.1.2.1.1.5	PROXIMAL PROBES	66	0	66	29	36	0	0	0
1.1.2.1.1.6	THEORY and COMPUTATION	22	0	22	15	7	0	0	0
1.1.2.1.1.7	CFN ENDSTATIONS AT NSLS	0	0	0	0	0	0	0	0
1.1.2.1.1.8	0.00	0	0	0	0	0	0	0	0
1.1.2.1.1.9	0.00	0	0	0	0	0	0	0	0
1.1.2.1.1.10	0.00	0	0	0	0	0	0	0	0
WBS TOTAL	**2002$**	**328**	**0**	**328**	175	153	0	0	0
WBS TOTAL	**AY$ COST**			**347**	183	164	0	0	0
	OBLIGATION			**347**	183	164	0	0	0

WBS NAME: **PE - TECHNICAL DESIGN** MANPOWER ESTIMATES SUMMARY IN HOURS & $1000

WBS NO. 1.1.2.1.1

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	2,420	1,210	0	0	0	**3,630**
ELECT ENGR	0	0	0	0	0	**0**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	220	110	0	0	0	**330**
DESIGN - ELECT	0	660	0	0	0	**660**
DESIGN - MECH	0	660	0	0	0	**660**
ADMIN	0	0	0	0	0	**0**
CONSTR. MGMT	0	0	0	0	0	**0**
TOT.S&P MANPOWER	2,640	1,320	0	0	0	**3,960**
TOT.OTHER MP	0	1,320	0	0	0	**1,320**
TOTAL MANPOWER	2,640	2,640	0	0	0	**5,280**
S&P DOLLARS	174.8	87.4	0.0	0.0	0.0	**262.1**
OTHER DOLLARS	0.0	65.5	0.0	0.0	0.0	**65.5**
TOTAL LABOR 2002$	174.8	152.9	0.0	0.0	0.0	**327.7**
Material 2002$	0.0	0.0	0.0	0.0	0.0	**0.0**

WBS NAME: **NANOPATTERNING**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.1.1.1

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	440	220	0	0	0	660
ELECT ENGR	0	0	0	0	0	0
MECH ENGR	0	0	0	0	0	0
COMPUTER ANALYST	0	0	0	0	0	0
DESIGN - ELECT	0	220	0	0	0	220
DESIGN - MECH	0	220	0	0	0	220
ADMIN	0	0	0	0	0	0
CONSTR. MGMT	0	0	0	0	0	0
						0
						0
TOT.S&P MANPOWER	440	220	0	0	0	660
TOT.OTHER MP	0	440	0	0	0	440
TOTAL MANPOWER	440	660	0	0	0	1,100
S&P DOLLARS	29.1	14.6	0.0	0.0	0.0	43.7
OTHER DOLLARS	0.0	21.8	0.0	0.0	0.0	21.8
TOTAL LABOR 2002$	29.1	36.4	0.0	0.0	0.0	65.5
Material 2002$						0.0

WBS NAME: **ULTRAFAST OPTICAL SOURCES**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.1.1.2

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	440	220	0	0	0	660
ELECT ENGR	0	0	0	0	0	0
MECH ENGR	0	0	0	0	0	0
COMPUTER ANALYST	0	0	0	0	0	0
DESIGN - ELECT	0	220	0	0	0	220
DESIGN - MECH	0	220	0	0	0	220
ADMIN	0	0	0	0	0	0
CONSTR. MGMT	0	0	0	0	0	0
						0
						0
TOT.S&P MANPOWER	440	220	0	0	0	660
TOT.OTHER MP	0	440	0	0	0	440
TOTAL MANPOWER	440	660	0	0	0	1100
S&P DOLLARS	29.1	14.6	0.0	0.0	0.0	43.7
OTHER DOLLARS	0.0	21.8	0.0	0.0	0.0	21.8
TOTAL LABOR 2002$	29.1	36.4	0.0	0.0	0.0	65.5
Material 2002$						0.0

WBS NAME: **ELECTRON MICROSCOPY** MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.1.1.3

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	880	440	0	0	0	**1320**
ELECT ENGR	0	0	0	0	0	**0**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
DESIGN - ELECT	0	0	0	0	0	**0**
DESIGN - MECH	0	0	0	0	0	**0**
ADMIN	0	0	0	0	0	**0**
CONSTR. MGMT	0	0	0	0	0	**0**
						0
						0
TOT.S&P MANPOWER	880	440	0	0	0	**1320**
TOT.OTHER MP	0	0	0	0	0	**0**
TOTAL MANPOWER	880	440	0	0	0	**1320**
S&P DOLLARS	58.3	29.1	0.0	0.0	0.0	**87.4**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	58.3	29.1	0.0	0.0	0.0	**87.4**
Material 2002$						**0.0**

WBS NAME: **MATERIALS SYNTHESIS** MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.1.1.4

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	220	110	0	0	0	**330**
ELECT ENGR	0	0	0	0	0	**0**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
DESIGN - ELECT	0	0	0	0	0	**0**
DESIGN - MECH	0	0	0	0	0	**0**
ADMIN	0	0	0	0	0	**0**
CONSTR. MGMT	0	0	0	0	0	**0**
						0
						0
TOT.S&P MANPOWER	220	110	0	0	0	**330**
TOT.OTHER MP	0	0	0	0	0	**0**
TOTAL MANPOWER	220	110	0	0	0	**330**
S&P DOLLARS	14.6	7.3	0.0	0.0	0.0	**21.8**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	14.6	7.3	0.0	0.0	0.0	**21.8**
Material 2002$						**0.0**

WBS NAME: **PROXIMAL PROBES**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.1.1.5

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	440	220	0	0	0	**660**
ELECT ENGR	0	0	0	0	0	**0**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
DESIGN - ELECT	0	220	0	0	0	**220**
DESIGN - MECH	0	220	0	0	0	**220**
ADMIN	0	0	0	0	0	**0**
CONSTR. MGMT	0	0	0	0	0	**0**
						0
						0
TOT.S&P MANPOWER	440	220	0	0	0	**660**
TOT.OTHER MP	0	440	0	0	0	**440**
TOTAL MANPOWER	440	660	0	0	0	**1100**
S&P DOLLARS	29.1	14.6	0.0	0.0	0.0	**43.7**
OTHER DOLLARS	0.0	21.8	0.0	0.0	0.0	**21.8**
TOTAL LABOR 2002$	29.1	36.4	0.0	0.0	0.0	**65.5**
Material 2002$						**0.0**

WBS NAME: **THEORY and COMPUTATION**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.1.1.6

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	0	0	0	**0**
ELECT ENGR	0	0	0	0	0	**0**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	220	110	0	0	0	**330**
DESIGN - ELECT	0	0	0	0	0	**0**
DESIGN - MECH	0	0	0	0	0	**0**
ADMIN	0	0	0	0	0	**0**
CONSTR. MGMT	0	0	0	0	0	**0**
						0
						0
TOT.S&P MANPOWER	220	110	0	0	0	**330**
TOT.OTHER MP	0	0	0	0	0	**0**
TOTAL MANPOWER	220	110	0	0	0	**330**
S&P DOLLARS	14.6	7.3	0.0	0.0	0.0	**21.8**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	14.6	7.3	0.0	0.0	0.0	**21.8**
Material 2002$						**0.0**

WBS NAME: **CFN ENDSTATIONS AT NSLS**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.1.1.7

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	0	0	0	**0**
ELECT ENGR	0	0	0	0	0	**0**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
DESIGN - ELECT	0	0	0	0	0	**0**
DESIGN - MECH	0	0	0	0	0	**0**
ADMIN	0	0	0	0	0	**0**
CONSTR. MGMT	0	0	0	0	0	**0**
						0
						0
TOT.S&P MANPOWER	0	0	0	0	0	**0**
TOT.OTHER MP	0	0	0	0	0	**0**
TOTAL MANPOWER	0	0	0	0	0	**0**
S&P DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	0.0	0.0	0.0	0.0	0.0	**0.0**
Material 2002$						**0.0**

WBS NAME: **PROJECT ENGRG - CONSTRUCTION PHASE** SUMMARY ESTIMATES IN 1000$

WBS NO. 1.1.2.2

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.1.2.2.1	PE - TECHNICAL CONSTRUCTION	**524**	**0**	**524**	0	255	269	0	0
1.1.2.2.2	PE - CONVENTIONAL CONSTRUCTION	**0**	**758**	**758**	0	378	279	101	0
1.1.2.2.3	0.00	**0**	**0**	**0**	0	0	0	0	0
1.1.2.2.4	0.00	**0**	**0**	**0**	0	0	0	0	0
1.1.2.2.5	0.00	**0**	**0**	**0**	0	0	0	0	0
1.1.2.2.6	0.00	**0**	**0**	**0**	0	0	0	0	0
1.1.2.2.7	0.00	**0**	**0**	**0**	0	0	0	0	0
1.1.2.2.8	0.00	**0**	**0**	**0**	0	0	0	0	0
1.1.2.2.9	0.00	**0**	**0**	**0**	0	0	0	0	0
1.1.2.2.10	0.00	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	524	758	**1,282**	0	633	548	101	0
WBS TOTAL	**AY$ COST**			**1,408**	0	518	649	195	47
	OBLIGATION			**1,408**	0	685	608	115	0

WBS NAME: **PROJECT ENGRG - CONSTRUCTION PHASE**

MANPOWER ESTIMATES SUMMARY
IN HOURS & $1000

WBS NO. 1.1.2.2

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	1,210	1,210	0	0	**2,420**
ELECT ENGR	0	1,100	1,100	0	0	**2,200**
MECH ENGR	0	1,100	1,100	0	0	**2,200**
COMPUTER ANALYST	0	110	0	0	0	**110**
DESIGN - ELECT	0	220	440	0	0	**660**
DESIGN - MECH	0	220	440	0	0	**660**
ADMIN	0	0	0	0	0	**0**
CONSTR. MGMT	0	0	0	0	0	**0**
TOT.S&P MANPOWER	0	3,520	3,410	0	0	**6,930**
TOT.OTHER MP	0	440	880	0	0	**1,320**
TOTAL MANPOWER	0	3,960	4,290	0	0	**8,250**
S&P DOLLARS	0.0	233.0	225.7	0.0	0.0	**458.8**
OTHER DOLLARS	0.0	21.8	43.7	0.0	0.0	**65.5**
TOTAL LABOR 2002$	0.0	254.9	269.4	0.0	0.0	**524.3**
Material 2002$	0.0	378.0	278.9	101.2	0.0	**758.1**

WBS NAME: **PE - TECHNICAL CONSTRUCTION**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.2.1

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	1,210	1,210	0	0	**2,420**
ELECT ENGR	0	1,100	1,100	0	0	**2,200**
MECH ENGR	0	1,100	1,100	0	0	**2,200**
COMPUTER ANALYST	0	110	0	0	0	**110**
DESIGN - ELECT	0	220	440	0	0	**660**
DESIGN - MECH	0	220	440	0	0	**660**
ADMIN	0	0	0	0	0	**0**
CONSTR. MGMT	0	0	0	0	0	**0**
						0
						0
TOT.S&P MANPOWER	0	3,520	3,410	0	0	**6,930**
TOT.OTHER MP	0	440	880	0	0	**1,320**
TOTAL MANPOWER	0	3,960	4,290	0	0	**8,250**
S&P DOLLARS	0.0	233.0	225.7	0.0	0.0	**458.8**
OTHER DOLLARS	0.0	21.8	43.7	0.0	0.0	**65.5**
TOTAL LABOR 2002$	0.0	254.9	269.4	0.0	0.0	**524.3**
Material 2002$						**0.0**

WBS NAME: **PE - CONVENTIONAL CONSTRUCTION**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.2.2

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	0	0	0	**0**
ELECT ENGR	0	0	0	0	0	**0**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
DESIGN - ELECT	0	0	0	0	0	**0**
DESIGN - MECH	0	0	0	0	0	**0**
ADMIN	0	0	0	0	0	**0**
CONSTR. MGMT	0	0	0	0	0	**0**
						0
						0
TOT.S&P MANPOWER	0	0	0	0	0	**0**
TOT.OTHER MP	0	0	0	0	0	**0**
TOTAL MANPOWER	0	0	0	0	0	**0**
S&P DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	0.0	0.0	0.0	0.0	0.0	**0.0**
Material 2002$	0.0	378.0	278.9	101.2	0.0	**758.1**

WBS NAME: **PE - TECHNICAL CONSTRUCTION** SUMMARY ESTIMATES
IN 1000$

WBS NO. 1.1.2.2.1

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.1.2.2.1.1	NANOPATTERNING	80	0	80	0	29	51	0	0
1.1.2.2.1.2	ULTRAFAST OPTICAL SOURCES	182	0	182	0	58	124	0	0
1.1.2.2.1.3	ELECTRON MICROSCOPY	58	0	58	0	29	29	0	0
1.1.2.2.1.4	MATERIALS SYNTHESIS	58	0	58	0	36	22	0	0
1.1.2.2.1.5	PROXIMAL PROBES	138	0	138	0	95	44	0	0
1.1.2.2.1.6	THEORY and COMPUTATION	7	0	7	0	7	0	0	0
1.1.2.2.1.7	CFN ENDSTATIONS AT NSLS	0	0	0	0	0	0	0	0
1.1.2.2.1.8	0.00	0	0	0	0	0	0	0	0
1.1.2.2.1.9	0.00	0	0	0	0	0	0	0	0
1.1.2.2.1.10	0.00	0	0	0	0	0	0	0	0
WBS TOTAL	**2002$**	**524**	**0**	**524**	0	255	269	0	0
WBS TOTAL	**AY$ COST**			**571**	0	274	297	0	0
	OBLIGATION			**571**	0	274	297	0	0

WBS NAME: **PE - TECHNICAL CONSTRUCTION** MANPOWER ESTIMATES SUMMARY
IN HOURS & $1000

WBS NO. 1.1.2.2.1

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	1,210	1,210	0	0	**2,420**
ELECT ENGR	0	1,100	1,100	0	0	**2,200**
MECH ENGR	0	1,100	1,100	0	0	**2,200**
COMPUTER ANALYST	0	110	0	0	0	**110**
DESIGN - ELECT	0	220	440	0	0	**660**
DESIGN - MECH	0	220	440	0	0	**660**
ADMIN	0	0	0	0	0	**0**
CONSTR. MGMT	0	0	0	0	0	**0**
TOT.S&P MANPOWER	0	3,520	3,410	0	0	**6,930**
TOT.OTHER MP	0	440	880	0	0	**1,320**
TOTAL MANPOWER	0	3,960	4,290	0	0	**8,250**
S&P DOLLARS	0.0	233.0	225.7	0.0	0.0	**458.8**
OTHER DOLLARS	0.0	21.8	43.7	0.0	0.0	**65.5**
TOTAL LABOR 2002$	0.0	254.9	269.4	0.0	0.0	**524.3**
Material 2002$	0.0	0.0	0.0	0.0	0.0	**0.0**

WBS NAME: **NANOPATTERNING**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.2.1.1

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	220	220	0	0	**440**
ELECT ENGR	0	220	220	0	0	**440**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
DESIGN - ELECT	0	0	220	0	0	**220**
DESIGN - MECH	0	0	220	0	0	**220**
ADMIN						**0**
CONSTR. MGMT						**0**
						0
						0
TOT.S&P MANPOWER	0	440	440	0	0	**880**
TOT.OTHER MP	0	0	440	0	0	**440**
TOTAL MANPOWER	0	440	880	0	0	**1,320**
S&P DOLLARS	0.0	29.1	29.1	0.0	0.0	**58.3**
OTHER DOLLARS	0.0	0.0	21.8	0.0	0.0	**21.8**
TOTAL LABOR 2002$	0.0	29.1	51.0	0.0	0.0	**80.1**
Material 2002$						**0.0**

WBS NAME: **ULTRAFAST OPTICAL SOURCES**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.2.1.2

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	220	220	0	0	**440**
ELECT ENGR	0	220	440	0	0	**660**
MECH ENGR	0	440	880	0	0	**1,320**
COMPUTER ANALYST	0	0	0	0	0	**0**
DESIGN - ELECT	0	0	220	0	0	**220**
DESIGN - MECH	0	0	220	0	0	**220**
ADMIN						**0**
CONSTR. MGMT						**0**
						0
						0
TOT.S&P MANPOWER	0	880	1,540	0	0	**2,420**
TOT.OTHER MP	0	0	440	0	0	**440**
TOTAL MANPOWER	0	880	1,980	0	0	**2,860**
S&P DOLLARS	0.0	58.3	101.9	0.0	0.0	**160.2**
OTHER DOLLARS	0.0	0.0	21.8	0.0	0.0	**21.8**
TOTAL LABOR 2002$	0.0	58.3	123.8	0.0	0.0	**182.0**
Material 2002$						**0.0**

WBS NAME: **ELECTRON MICROSCOPY**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.2.1.3

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	440	440	0	0	**880**
ELECT ENGR	0	0	0	0	0	**0**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
DESIGN - ELECT	0	0	0	0	0	**0**
DESIGN - MECH	0	0	0	0	0	**0**
ADMIN						**0**
CONSTR. MGMT						**0**
						0
						0
TOT.S&P MANPOWER	0	440	440	0	0	**880**
TOT.OTHER MP	0	0	0	0	0	**0**
TOTAL MANPOWER	0	440	440	0	0	**880**
S&P DOLLARS	0.0	29.1	29.1	0.0	0.0	**58.3**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	0.0	29.1	29.1	0.0	0.0	**58.3**
Material 2002$						**0.0**

WBS NAME: **MATERIALS SYNTHESIS**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.2.1.4

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	110	110	0	0	**220**
ELECT ENGR	0	220	220	0	0	**440**
MECH ENGR	0	220	0	0	0	**220**
COMPUTER ANALYST	0	0	0	0	0	**0**
DESIGN - ELECT	0	0	0	0	0	**0**
DESIGN - MECH	0	0	0	0	0	**0**
ADMIN						**0**
CONSTR. MGMT						**0**
						0
						0
TOT.S&P MANPOWER	0	550	330	0	0	**880**
TOT.OTHER MP	0	0	0	0	0	**0**
TOTAL MANPOWER	0	550	330	0	0	**880**
S&P DOLLARS	0.0	36.4	21.8	0.0	0.0	**58.3**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	0.0	36.4	21.8	0.0	0.0	**58.3**
Material 2002$						**0.0**

WBS NAME: **PROXIMAL PROBES**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.2.1.5

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	220	220	0	0	**440**
ELECT ENGR	0	440	220	0	0	**660**
MECH ENGR	0	440	220	0	0	**660**
COMPUTER ANALYST	0	0	0	0	0	**0**
DESIGN - ELECT	0	220	0	0	0	**220**
DESIGN - MECH	0	220	0	0	0	**220**
ADMIN						**0**
CONSTR. MGMT						**0**
						0
						0
TOT.S&P MANPOWER	0	1,100	660	0	0	**1,760**
TOT.OTHER MP	0	440	0	0	0	**440**
TOTAL MANPOWER	0	1,540	660	0	0	**2,200**
S&P DOLLARS	0.0	72.8	43.7	0.0	0.0	**116.5**
OTHER DOLLARS	0.0	21.8	0.0	0.0	0.0	**21.8**
TOTAL LABOR 2002$	0.0	94.7	43.7	0.0	0.0	**138.4**
Material 2002$						**0.0**

WBS NAME: **THEORY and COMPUTATION**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.2.1.6

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	0	0	0	**0**
ELECT ENGR	0	0	0	0	0	**0**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	0	110	0	0	0	**110**
DESIGN - ELECT	0	0	0	0	0	**0**
DESIGN - MECH	0	0	0	0	0	**0**
ADMIN						**0**
CONSTR. MGMT						**0**
						0
						0
TOT.S&P MANPOWER	0	110	0	0	0	**110**
TOT.OTHER MP	0	0	0	0	0	**0**
TOTAL MANPOWER	0	110	0	0	0	**110**
S&P DOLLARS	0.0	7.3	0.0	0.0	0.0	**7.3**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	0.0	7.3	0.0	0.0	0.0	**7.3**
Material 2002$						**0.0**

WBS NAME: **CFN ENDSTATIONS AT NSLS**

MANPOWER ESTIMATES
IN HOURS & $1000

WBS NO. 1.1.2.2.1.7

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	0	0	0	**0**
ELECT ENGR	0	0	0	0	0	**0**
MECH ENGR	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
DESIGN - ELECT	0	0	0	0	0	**0**
DESIGN - MECH	0	0	0	0	0	**0**
ADMIN						**0**
CONSTR. MGMT						**0**
						0
						0
TOT.S&P MANPOWER	0	0	0	0	0	**0**
TOT.OTHER MP	0	0	0	0	0	**0**
TOTAL MANPOWER	0	0	0	0	0	**0**
S&P DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	0.0	0.0	0.0	0.0	0.0	**0.0**
Material 2002$						**0.0**

WBS NO 1.2 **TECHNICAL CONSTRUCTION** TOTAL COST AND OBLIGATION

		TOTAL	2004	2005	2006	2007	2008
TOTAL LABOR AY$		2,351	0	19	740	1,263	328
TOTAL MSTC	AY$ COST	27,899	0	3,577	13,245	9,525	1,552
	OBLIGATION	27,899	0	6,024	18,166	3,628	81
TOTAL COST	AY$	30,250	0	3,597	13,985	10,789	1,880
TOTAL OBLIGATION	AY$	30,250	0	6,044	18,906	4,892	409

NOTE: MSTC AY$ include both escallation and material shift.

1.2	**TECHNICAL CONSTRUCTION**	Contngy %	Contngy 2002$
1.2.1	NANOPATTERNING	25.0%	1,667
1.2.2	ULTRAFAST OPTICAL SOURCES	20.0%	568
1.2.3	ELECTRON MICROSCOPY	25.0%	1,964
1.2.4	MATERIALS SYNTHESIS	25.0%	867
1.2.5	PROXIMAL PROBES	25.0%	1,236
1.2.6	THEORY and COMPUTATION	20.0%	98
1.2.7	CFN ENDSTATIONS AT NSLS	20.0%	186
1.2.8		0.0%	0
1.2.9		0.0%	0
1.2.10		0.0%	0
		24.2%	6,586

WBS NAME: **TECHNICAL CONSTRUCTION** SUMMARY ESTIMATES
IN 1000$

WBS NO. 1.2

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.2.1	NANOPATTERNING	**102**	**6,567**	**6,669**	0	4,500	2,046	108	15
1.2.2	ULTRAFAST OPTICAL SOURCES	**359**	**2,483**	**2,842**	0	0	1,060	1,725	56
1.2.3	ELECTRON MICROSCOPY	**488**	**7,369**	**7,856**	0	0	7,015	747	94
1.2.4	MATERIALS SYNTHESIS	**557**	**2,909**	**3,466**	0	81	2,572	734	78
1.2.5	PROXIMAL PROBES	**519**	**4,425**	**4,944**	0	980	3,060	835	69
1.2.6	THEORY and COMPUTATION	**66**	**422**	**488**	0	0	295	151	42
1.2.7	CFN ENDSTATIONS AT NSLS	**0**	**930**	**930**	0	0	930	0	0
1.2.8	0	**0**	**0**	**0**	0	0	0	0	0
1.2.9	0	**0**	**0**	**0**	0	0	0	0	0
1.2.10	0	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	2,091	25,104	27,195	0	5,561	16,978	4,301	354
WBS TOTAL	**AY$ COST**			**30,250**	0	3,597	13,985	10,789	1,880
	OBLIGATION			**30,250**	0	6,044	18,906	4,892	409

WBS NAME: **NANOPATTERNING** SUMMARY ESTIMATES
IN 1000$

WBS NO. 1.2.1

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.2.1.1	NANOPATTERNING	**102**	**6,567**	**6,669**	0	4,500	2,046	108	15
1.2.1.2	0	**0**	**0**	**0**	0	0	0	0	0
1.2.1.3	0	**0**	**0**	**0**	0	0	0	0	0
1.2.1.4	0	**0**	**0**	**0**	0	0	0	0	0
1.2.1.5	0	**0**	**0**	**0**	0	0	0	0	0
1.2.1.6	0	**0**	**0**	**0**	0	0	0	0	0
1.2.1.7	0	**0**	**0**	**0**	0	0	0	0	0
1.2.1.8	0	**0**	**0**	**0**	0	0	0	0	0
1.2.1.9	0	**0**	**0**	**0**	0	0	0	0	0
1.2.1.10	0	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	**102**	**6,567**	**6,669**	0	4,500	2,046	108	15
WBS TOTAL	**AY$ COST**			**7,309**	0	2,904	3,354	1,011	40
	OBLIGATION			**7,309**	0	4,890	2,279	123	17

WBS NAME: **NANOPATTERNING** MANPOWER ESTIMATE SUMMARY
IN HOURS & $1000

WBS NO. 1.2.1

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	220	660	220	**1,100**
COMPUTER ANALYST	0	0	220	220	0	**440**
TECH - VACUUM	0	0	0	0	0	**0**
TECH - ELECT	0	0	0	0	0	**0**
TECH - MECH	0	0	0	0	0	**0**
CENTRAL SHOPS	0	0	0	0	0	**0**
PLT ENGRG (TRADES)	0	0	0	0	0	**0**
TOT.S&P MANPOWER	0	0	440	880	220	**1,540**
TOT.OTHER MP	0	0	0	0	0	**0**
TOT.TRADE MP	0	0	0	0	0	**0**
TOTAL MANPOWER	0	0	440	880	220	**1,540**
S&P DOLLARS	0.0	0.0	29.1	58.3	14.6	**101.9**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TRADE DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	0.0	0.0	29.1	58.3	14.6	**101.9**
Material 2002$	0.0	4,500.0	2,017.1	50.0	0.0	**6,567.1**

WBS NAME: **ULTRAFAST OPTICAL SOURCES** SUMMARY ESTIMATES
IN 1000$

WBS NO. 1.2.2

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.2.2.1	ULTRAFAST OPTICAL SOURCES	**359**	**2,483**	**2,842**	0	0	1,060	1,725	56
1.2.2.2	0	**0**	**0**	**0**	0	0	0	0	0
1.2.2.3	0	**0**	**0**	**0**	0	0	0	0	0
1.2.2.4	0	**0**	**0**	**0**	0	0	0	0	0
1.2.2.5	0	**0**	**0**	**0**	0	0	0	0	0
1.2.2.6	0	**0**	**0**	**0**	0	0	0	0	0
1.2.2.7	0	**0**	**0**	**0**	0	0	0	0	0
1.2.2.8	0	**0**	**0**	**0**	0	0	0	0	0
1.2.2.9	0	**0**	**0**	**0**	0	0	0	0	0
1.2.2.10	0	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	**359**	**2,483**	**2,842**	0	0	1,060	1,725	56
WBS TOTAL	**AY$ COST**			**3,210**	0	0	721	1,745	743
	OBLIGATION			**3,210**	0	0	1,180	1,964	65

WBS NAME: **ULTRAFAST OPTICAL SOURCES** MANPOWER ESTIMATE SUMMARY
IN HOURS & $1000

WBS NO. 1.2.2

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	660	1,320	440	**2,420**
COMPUTER ANALYST	0	0	0	0	0	**0**
TECH - VACUUM	0	0	0	330	110	**440**
TECH - ELECT	0	0	0	660	220	**880**
TECH - MECH	0	0	0	660	220	**880**
CENTRAL SHOPS	0	0	0	880	0	**880**
PLT ENGRG (TRADES)	0	0	0	220	0	**220**
TOT.S&P MANPOWER	0	0	660	1,320	440	**2,420**
TOT.OTHER MP	0	0	0	1,650	550	**2,200**
TOT.TRADE MP	0	0	0	1,100	0	**1,100**
TOTAL MANPOWER	0	0	660	4,070	990	**5,720**
S&P DOLLARS	0.0	0.0	43.7	87.4	29.1	**160.2**
OTHER DOLLARS	0.0	0.0	0.0	81.9	27.3	**109.2**
TRADE DOLLARS	0.0	0.0	0.0	89.6	0.0	**89.6**
TOTAL LABOR 2002$	0.0	0.0	43.7	258.9	56.4	**359.0**
Material 2002$	0.0	0.0	1,016.3	1,466.5	0.0	**2,482.7**

WBS NAME: **ELECTRON MICROSCOPY** SUMMARY ESTIMATES
IN 1000$

WBS NO. 1.2.3

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.2.3.1	ELECTRON MICROSCOPY	**488**	**7,369**	**7,856**	0	0	7,015	747	94
1.2.3.2	0	**0**	**0**	**0**	0	0	0	0	0
1.2.3.3	0	**0**	**0**	**0**	0	0	0	0	0
1.2.3.4	0	**0**	**0**	**0**	0	0	0	0	0
1.2.3.5	0	**0**	**0**	**0**	0	0	0	0	0
1.2.3.6	0	**0**	**0**	**0**	0	0	0	0	0
1.2.3.7	0	**0**	**0**	**0**	0	0	0	0	0
1.2.3.8	0	**0**	**0**	**0**	0	0	0	0	0
1.2.3.9	0	**0**	**0**	**0**	0	0	0	0	0
1.2.3.10	0	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	**488**	**7,369**	**7,856**	0	0	7,015	747	94
WBS TOTAL	**AY$ COST**			**8,770**	0	0	4,732	3,699	339
	OBLIGATION			**8,770**	0	0	7,813	849	108

WBS NAME: **ELECTRON MICROSCOPY** MANPOWER ESTIMATE SUMMARY
IN HOURS & $1000

WBS NO. 1.2.3

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	2,200	2,860	660	**5,720**
COMPUTER ANALYST	0	0	770	880	0	**1,650**
TECH - VACUUM	0	0	0	0	0	**0**
TECH - ELECT	0	0	0	0	0	**0**
TECH - MECH	0	0	0	0	0	**0**
CENTRAL SHOPS	0	0	0	0	0	**0**
PLT ENGRG (TRADES)	0	0	0	0	0	**0**
TOT.S&P MANPOWER	0	0	2,970	3,740	660	**7,370**
TOT.OTHER MP	0	0	0	0	0	**0**
TOT.TRADE MP	0	0	0	0	0	**0**
TOTAL MANPOWER	0	0	2,970	3,740	660	**7,370**
S&P DOLLARS	0.0	0.0	196.6	247.6	43.7	**487.9**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TRADE DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	0.0	0.0	196.6	247.6	43.7	**487.9**
Material 2002$	0.0	0.0	6,818.9	499.6	50.0	**7,368.5**

WBS NAME: **MATERIALS SYNTHESIS** SUMMARY ESTIMATES

IN 1000$

WBS NO. 1.2.4

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.2.4.1	MATERIALS SYNTHESIS	**557**	**2,909**	**3,466**	0	81	2,572	734	78
1.2.4.2	0	**0**	**0**	**0**	0	0	0	0	0
1.2.4.3	0	**0**	**0**	**0**	0	0	0	0	0
1.2.4.4	0	**0**	**0**	**0**	0	0	0	0	0
1.2.4.5	0	**0**	**0**	**0**	0	0	0	0	0
1.2.4.6	0	**0**	**0**	**0**	0	0	0	0	0
1.2.4.7	0	**0**	**0**	**0**	0	0	0	0	0
1.2.4.8	0	**0**	**0**	**0**	0	0	0	0	0
1.2.4.9	0	**0**	**0**	**0**	0	0	0	0	0
1.2.4.10	0	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	**557**	**2,909**	**3,466**	0	81	2,572	734	78
WBS TOTAL	**AY$ COST**			**3,876**	0	60	1,817	1,693	307
	OBLIGATION			**3,876**	0	88	2,863	834	90

WBS NAME: **MATERIALS SYNTHESIS** MANPOWER ESTIMATE SUMMARY

IN HOURS & $1000

WBS NO. 1.2.4

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	1,210	1,320	440	**2,970**
COMPUTER ANALYST	0	0	0	0	0	**0**
TECH - VACUUM	0	0	880	1,210	550	**2,640**
TECH - ELECT	0	0	0	0	0	**0**
TECH - MECH	0	0	880	1,320	440	**2,640**
CENTRAL SHOPS	0	0	110	440	0	**550**
PLT ENGRG (TRADES)	0	220	220	220	0	**660**
TOT.S&P MANPOWER	0	0	1,210	1,320	440	**2,970**
TOT.OTHER MP	0	0	1,760	2,530	990	**5,280**
TOT.TRADE MP	0	220	330	660	0	**1,210**
TOTAL MANPOWER	0	220	3,300	4,510	1,430	**9,460**
S&P DOLLARS	0.0	0.0	80.1	87.4	29.1	**196.6**
OTHER DOLLARS	0.0	0.0	87.4	125.6	49.2	**262.1**
TRADE DOLLARS	0.0	17.9	26.9	53.8	0.0	**98.6**
TOTAL LABOR 2002$	0.0	17.9	194.4	266.7	78.3	**557.3**
Material 2002$	0.0	63.6	2,377.8	467.6	0.0	**2,909.0**

WBS NAME: **PROXIMAL PROBES** SUMMARY ESTIMATES IN 1000$

WBS NO. 1.2.5

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.2.5.1	PROXIMAL PROBES	**519**	**4,425**	**4,944**	0	980	3,060	835	69
1.2.5.2	0	**0**	**0**	**0**	0	0	0	0	0
1.2.5.3	0	**0**	**0**	**0**	0	0	0	0	0
1.2.5.4	0	**0**	**0**	**0**	0	0	0	0	0
1.2.5.5	0	**0**	**0**	**0**	0	0	0	0	0
1.2.5.6	0	**0**	**0**	**0**	0	0	0	0	0
1.2.5.7	0	**0**	**0**	**0**	0	0	0	0	0
1.2.5.8	0	**0**	**0**	**0**	0	0	0	0	0
1.2.5.9	0	**0**	**0**	**0**	0	0	0	0	0
1.2.5.10	0	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	**519**	**4,425**	**4,944**	0	980	3,060	835	69
WBS TOTAL	**AY$ COST**			**5,501**	0	632	2,543	1,978	347
	OBLIGATION			**5,501**	0	1,065	3,406	949	80

WBS NAME: **PROXIMAL PROBES** MANPOWER ESTIMATE SUMMARY IN HOURS & $1000

WBS NO. 1.2.5

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	1,980	2,640	440	**5,060**
COMPUTER ANALYST	0	0	110	220	110	**440**
TECH - VACUUM	0	0	0	220	220	**440**
TECH - ELECT	0	0	0	220	220	**440**
TECH - MECH	0	0	0	220	220	**440**
CENTRAL SHOPS	0	0	440	220	0	**660**
PLT ENGRG (TRADES)	0	0	220	220	0	**440**
TOT.S&P MANPOWER	0	0	2,090	2,860	550	**5,500**
TOT.OTHER MP	0	0	0	660	660	**1,320**
TOT.TRADE MP	0	0	660	440	0	**1,100**
TOTAL MANPOWER	0	0	2,750	3,960	1,210	**7,920**
S&P DOLLARS	0.0	0.0	138.4	189.3	36.4	**364.1**
OTHER DOLLARS	0.0	0.0	0.0	32.8	32.8	**65.5**
TRADE DOLLARS	0.0	0.0	53.8	35.8	0.0	**89.6**
TOTAL LABOR 2002$	0.0	0.0	192.1	257.9	69.2	**519.2**
Material 2002$	0.0	980.0	2,867.7	577.2	0.0	**4,424.9**

WBS NAME: **THEORY and COMPUTATION**

SUMMARY ESTIMATES
IN 1000$

WBS NO. 1.2.6

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.2.6.1	THEORY and COMPUTATION	66	422	488	0	0	295	151	42
1.2.6.2	0	0	0	0	0	0	0	0	0
1.2.6.3	0	0	0	0	0	0	0	0	0
1.2.6.4	0	0	0	0	0	0	0	0	0
1.2.6.5	0	0	0	0	0	0	0	0	0
1.2.6.6	0	0	0	0	0	0	0	0	0
1.2.6.7	0	0	0	0	0	0	0	0	0
1.2.6.8	0	0	0	0	0	0	0	0	0
1.2.6.9	0	0	0	0	0	0	0	0	0
1.2.6.10	0	0	0	0	0	0	0	0	0
WBS TOTAL	**2002$**	66	422	488	0	0	295	151	42
WBS TOTAL	**AY$ COST**			549	0	0	202	242	105
	OBLIGATION			549	0	0	328	172	48

WBS NAME: **THEORY and COMPUTATION**

MANPOWER ESTIMATE SUMMARY
IN HOURS & $1000

WBS NO. 1.2.6

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	0	0	0	0
COMPUTER ANALYST	0	0	220	440	330	990
TECH - VACUUM	0	0	0	0	0	0
TECH - ELECT	0	0	0	0	0	0
TECH - MECH	0	0	0	0	0	0
CENTRAL SHOPS	0	0	0	0	0	0
PLT ENGRG (TRADES)	0	0	0	0	0	0
TOT.S&P MANPOWER	0	0	220	440	330	990
TOT.OTHER MP	0	0	0	0	0	0
TOT.TRADE MP	0	0	0	0	0	0
TOTAL MANPOWER	0	0	220	440	330	990
S&P DOLLARS	0.0	0.0	14.6	29.1	21.8	65.5
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	0.0
TRADE DOLLARS	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL LABOR 2002$	0.0	0.0	14.6	29.1	21.8	65.5
Material 2002$	0.0	0.0	280.2	122.0	20.0	422.2

WBS NAME: **CFN ENDSTATIONS AT NSLS** SUMMARY ESTIMATES
IN 1000$

WBS NO. 1.2.7

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.2.7.1	CFN ENDSTATIONS AT NSLS	0	930	930	0	0	930	0	0
1.2.7.2	0	0	0	0	0	0	0	0	0
1.2.7.3	0	0	0	0	0	0	0	0	0
1.2.7.4	0	0	0	0	0	0	0	0	0
1.2.7.5	0	0	0	0	0	0	0	0	0
1.2.7.6	0	0	0	0	0	0	0	0	0
1.2.7.7	0	0	0	0	0	0	0	0	0
1.2.7.8	0	0	0	0	0	0	0	0	0
1.2.7.9	0	0	0	0	0	0	0	0	0
1.2.7.10	0	0	0	0	0	0	0	0	0
WBS TOTAL	**2002$**	0	930	930	0	0	930	0	0
WBS TOTAL	**AY$ COST**			**1,036**	0	0	616	420	0
	OBLIGATION			**1,036**	0	0	1,036	0	0

WBS NAME: **CFN ENDSTATIONS AT NSLS** MANPOWER ESTIMATE SUMMARY
IN HOURS & $1000

WBS NO. 1.2.7

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
TECH - VACUUM	0	0	0	0	0	**0**
TECH - ELECT	0	0	0	0	0	**0**
TECH - MECH	0	0	0	0	0	**0**
CENTRAL SHOPS	0	0	0	0	0	**0**
PLT ENGRG (TRADES)	0	0	0	0	0	**0**
TOT.S&P MANPOWER	0	0	0	0	0	**0**
TOT.OTHER MP	0	0	0	0	0	**0**
TOT.TRADE MP	0	0	0	0	0	**0**
TOTAL MANPOWER	0	0	0	0	0	**0**
S&P DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TRADE DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	0.0	0.0	0.0	0.0	0.0	**0.0**
Material 2002$	0.0	0.0	930.0	0.0	0.0	**930.0**

WBS NO 1.3 **CONVENT. CONSTR.** TOTAL COST AND OBLIGATION

	TOTAL	2004	2005	2006	2007	2008
TOTAL LABOR AY$	0	0	0	0	0	0
TOTAL MSTC AY$ COST	27,260	0	5,850	11,537	7,954	1,918
OBLIGATION	27,260	0	9,852	12,676	4,731	0
TOTAL COST AY$	27,260	0	5,850	11,537	7,954	1,918
TOTAL OBLIGATION AY$	27,260	0	9,852	12,676	4,731	0

NOTE: MSTC AY$ include both escallation and material shift.

1.3	**CONVENT. CONSTR.**	Contngy %	Contngy 2002$
1.3.1	IMPROVEMENTS TO LAND	9.0%	72
1.3.2	BUILDINGS	17.5%	3,582
1.3.3	UTILITIES	15.0%	499
1.3.4		0.0%	0
1.3.5		0.0%	0
1.3.6		0.0%	0
1.3.7		0.0%	0
1.3.8		0.0%	0
1.3.9		0.0%	0
1.3.10		0.0%	0
		16.9%	4,153

WBS NAME: **CONVENT. CONSTR.** SUMMARY ESTIMATES
IN 1000$

WBS NO. 1.3

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.3.1	IMPROVEMENTS TO LAND	**0**	**801**	**801**	0	267	401	134	0
1.3.2	BUILDINGS	**0**	**20,469**	**20,469**	0	6,859	9,846	3,764	0
1.3.3	UTILITIES	**0**	**3,326**	**3,326**	0	1,940	1,133	253	0
1.3.4	0	**0**	**0**	**0**	0	0	0	0	0
1.3.5	0	**0**	**0**	**0**	0	0	0	0	0
1.3.6	0	**0**	**0**	**0**	0	0	0	0	0
1.3.7	0	**0**	**0**	**0**	0	0	0	0	0
1.3.8	0	**0**	**0**	**0**	0	0	0	0	0
1.3.9	0	**0**	**0**	**0**	0	0	0	0	0
1.3.10	0	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	**0**	**24,596**	**24,596**	0	9,066	11,380	4,151	0
WBS TOTAL	**AY$ COST**			**27,260**	0	5,850	11,537	7,954	1,918
	OBLIGATION			**27,260**	0	9,852	12,676	4,731	0

WBS NAME: **IMPROVEMENTS TO LAND** SUMMARY ESTIMATES
IN 1000$

WBS NO. 1.3.1

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.3.1.1	IMPROVEMENTS TO LAND	**0**	**801**	**801**	0	267	401	134	0
1.3.1.2	0	**0**	**0**	**0**	0	0	0	0	0
1.3.1.3	0	**0**	**0**	**0**	0	0	0	0	0
1.3.1.4	0	**0**	**0**	**0**	0	0	0	0	0
1.3.1.5	0	**0**	**0**	**0**	0	0	0	0	0
1.3.1.6	0	**0**	**0**	**0**	0	0	0	0	0
1.3.1.7	0	**0**	**0**	**0**	0	0	0	0	0
1.3.1.8	0	**0**	**0**	**0**	0	0	0	0	0
1.3.1.9	0	**0**	**0**	**0**	0	0	0	0	0
1.3.1.10	0	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	**0**	**801**	**801**	0	267	401	134	0
WBS TOTAL	**AY$ COST**			**889**	0	172	383	272	62
	OBLIGATION			**889**	0	290	446	152	0

WBS NAME: **IMPROVEMENTS TO LAND** MANPOWER ESTIMATE SUMMARY
IN HOURS & $1000

WBS NO. 1.3.1

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
TECH - VACUUM	0	0	0	0	0	**0**
TECH - ELECT	0	0	0	0	0	**0**
TECH - MECH	0	0	0	0	0	**0**
CENTRAL SHOPS	0	0	0	0	0	**0**
PLT ENGRG (TRADES)	0	0	0	0	0	**0**
TOT.S&P MANPOWER	0	0	0	0	0	**0**
TOT.OTHER MP	0	0	0	0	0	**0**
TOT.TRADE MP	0	0	0	0	0	**0**
TOTAL MANPOWER	0	0	0	0	0	**0**
S&P DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TRADE DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	0.0	0.0	0.0	0.0	0.0	**0.0**
Material 2002$	0.0	267.2	400.7	133.5	0.0	**801.4**

WBS NAME: **BUILDINGS** SUMMARY ESTIMATES
IN 1000$

WBS NO. 1.3.2

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.3.4.1	BUILDINGS	**0**	**20,469**	**20,469**	0	6,859	9,846	3,764	0
1.3.4.2	0	**0**	**0**	**0**	0	0	0	0	0
1.3.4.3	0	**0**	**0**	**0**	0	0	0	0	0
1.3.4.4	0	**0**	**0**	**0**	0	0	0	0	0
1.3.4.5	0	**0**	**0**	**0**	0	0	0	0	0
1.3.4.6	0	**0**	**0**	**0**	0	0	0	0	0
1.3.4.7	0	**0**	**0**	**0**	0	0	0	0	0
1.3.4.8	0	**0**	**0**	**0**	0	0	0	0	0
1.3.4.9	0	**0**	**0**	**0**	0	0	0	0	0
1.3.4.10	0	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	**0**	**20,469**	**20,469**	0	6,859	9,846	3,764	0
WBS TOTAL	**AY$ COST**			**22,712**	0	4,426	9,547	6,999	1,740
	OBLIGATION			**22,712**	0	7,453	10,968	4,290	0

WBS NAME: **BUILDINGS** MANPOWER ESTIMATE SUMMARY
IN HOURS & $1000

WBS NO. 1.3.2

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
TECH - VACUUM	0	0	0	0	0	**0**
TECH - ELECT	0	0	0	0	0	**0**
TECH - MECH	0	0	0	0	0	**0**
CENTRAL SHOPS	0	0	0	0	0	**0**
PLT ENGRG (TRADES)	0	0	0	0	0	**0**
TOT.S&P MANPOWER	0	0	0	0	0	**0**
TOT.OTHER MP	0	0	0	0	0	**0**
TOT.TRADE MP	0	0	0	0	0	**0**
TOTAL MANPOWER	0	0	0	0	0	**0**
S&P DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TRADE DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	0.0	0.0	0.0	0.0	0.0	**0.0**
Material 2002$	0.0	6,858.6	9,846.3	3,763.8	0.0	**20,468.7**

WBS NAME: **UTILITIES**

SUMMARY ESTIMATES
IN 1000$

WBS NO. 1.3.3

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.3.3.1	UTILITIES	**0**	**3,326**	**3,326**	0	1,940	1,133	253	0
1.3.3.2	0	**0**	**0**	**0**	0	0	0	0	0
1.3.3.3	0	**0**	**0**	**0**	0	0	0	0	0
1.3.3.4	0	**0**	**0**	**0**	0	0	0	0	0
1.3.3.5	0	**0**	**0**	**0**	0	0	0	0	0
1.3.3.6	0	**0**	**0**	**0**	0	0	0	0	0
1.3.3.7	0	**0**	**0**	**0**	0	0	0	0	0
1.3.3.8	0	**0**	**0**	**0**	0	0	0	0	0
1.3.3.9	0	**0**	**0**	**0**	0	0	0	0	0
1.3.3.10	0	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	**0**	**3,326**	**3,326**	0	1,940	1,133	253	0
WBS TOTAL	**AY$ COST**			**3,659**	0	1,252	1,606	683	117
	OBLIGATION			**3,659**	0	2,109	1,262	289	0

WBS NAME: **UTILITIES**

MANPOWER ESTIMATE SUMMARY
IN HOURS & $1000

WBS NO. 1.3.3

	2004	2005	2006	2007	2008	TOTAL
PHYSICIST	0	0	0	0	0	**0**
COMPUTER ANALYST	0	0	0	0	0	**0**
TECH - VACUUM	0	0	0	0	0	**0**
TECH - ELECT	0	0	0	0	0	**0**
TECH - MECH	0	0	0	0	0	**0**
CENTRAL SHOPS	0	0	0	0	0	**0**
PLT ENGRG (TRADES)	0	0	0	0	0	**0**
TOT.S&P MANPOWER	0	0	0	0	0	**0**
TOT.OTHER MP	0	0	0	0	0	**0**
TOT.TRADE MP	0	0	0	0	0	**0**
TOTAL MANPOWER	0	0	0	0	0	**0**
S&P DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
OTHER DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TRADE DOLLARS	0.0	0.0	0.0	0.0	0.0	**0.0**
TOTAL LABOR 2002$	0.0	0.0	0.0	0.0	0.0	**0.0**
Material 2002$	0.0	1,940.3	1,132.7	253.2	0.0	**3,326.2**

WBS NO 1.4 **STANDARD EQUIPMENT** TOTAL COST AND OBLIGATION

		TOTAL	2004	2005	2006	2007	2008
TOTAL LABOR AY$		0	0	0	0	0	0
TOTAL MSTC	AY$ COST	1,151	0	0	0	684	467
	OBLIGATION	1,151	0	0	0	1,151	0
TOTAL COST	AY$	1,151	0	0	0	684	467
TOTAL OBLIGATION	AY$	1,151	0	0	0	1,151	0

NOTE: MSTC AY$ include both escallation and material shift.

		Contngy %	Contngy 2002$
1.4	**STANDARD EQUIPMENT**		
1.4.1	STANDARD EQUIPMENT	5.0%	50
1.4.2		0.0%	0
1.4.3		0.0%	0
1.4.4		0.0%	0
1.4.5		0.0%	0
1.4.6		0.0%	0
1.4.7		0.0%	0
1.4.8		0.0%	0
1.4.9		0.0%	0
1.4.10		0.0%	0
		5.0%	50

WBS NAME: **STANDARD EQUIPMENT** SUMMARY ESTIMATES
IN 1000$

WBS NO. 1.4

		LABOR	MATL	TOTAL	2004	2005	2006	2007	2008
1.4.1	STANDARD EQUIPMENT	**0**	**1,010**	**1,010**	0	0	0	1,010	0
1.4.2	0	**0**	**0**	**0**	0	0	0	0	0
1.4.3	0	**0**	**0**	**0**	0	0	0	0	0
1.4.4	0	**0**	**0**	**0**	0	0	0	0	0
1.4.5	0	**0**	**0**	**0**	0	0	0	0	0
1.4.6	0	**0**	**0**	**0**	0	0	0	0	0
1.4.7	0	**0**	**0**	**0**	0	0	0	0	0
1.4.8	0	**0**	**0**	**0**	0	0	0	0	0
1.4.9	0	**0**	**0**	**0**	0	0	0	0	0
1.4.10	0	**0**	**0**	**0**	0	0	0	0	0
WBS TOTAL	**2002$**	**0**	**1,010**	**1,010**	0	0	0	1,010	0
WBS TOTAL	**AY$ COST**			**1,151**	0	0	0	684	467
	OBLIGATION			**1,151**	0	0	0	1,151	0

BNL CENTER FOR FUNCTIONAL NANOMATERIALS
MATERIAL ESTIMATE BACK-UP
DOLLARS X 1000

WBS NAME: Nanopatterning

WBS NO: 1.2.1

C = CATALOG PRICE
E = ENG'RG ESTIMATE
V = VENDOR QUOTE

DESCRIPTION	UNIT PRICE	QTY	***	QA	2004	2005	2006	2007	2008	TOTAL
JEOL 9300 FS Electron Beam Lithography Unit	4500	1	V			4,500.0				4,500.0
										-
FEI Focused Ion Beam lithography Tool	1200	1	V				1,200.0			1,200.0
										-
EVG 150 Development Station	282.134	1	V				282.1			282.1
										-
Oxford Plasma Lab Etcher	535	1	V				535.0			535.0
										-
Lab Hardware, Computers, & Electronics	50	1	E					50.0		50.0
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
TOTAL					-	4,500.0	2,017.1	50.0	-	6,567.1

BNL CENTER FOR FUNCTIONAL NANOMATERIALS
MATERIAL ESTIMATE BACK-UP
DOLLARS X 1000

WBS NAME: Ultrafast Optical Sources

WBS NO: 1.2.2

C = CATALOG PRICE
E = ENG'RG ESTIMATE
V = VENDOR QUOTE

DESCRIPTION	UNIT PRICE	QTY	***	QA	2004	2005	2006	2007	2008	TOTAL
0.01-2.5 kHz 4 mJ 800 nm laserSystem	**362.725**	**2**					**725.5**			**725.5**
Quantronix 527 DQ-S amplifier pump laser	49.5	1	v							-
Spectra Physics Millenia Vs-J oscillator pump laser	53	1	v							-
Spectra Physics Tsunami 35 fsec oscillator	65	1	v							-
Lok to Clok synchronization for Tsunami, 500 fsec	28.8	1	v							-
chiller for Spectra lasers	3.25	1	v							-
stretcher/compressor	30	1	e,v							-
Ti: Sapphire Crystal 9x22mm	1.25	2	v							-
optics and mounts for regenerative amplifier cavity		1	e							-
Medox two-step pockel cell head and controller	18	1								-
vacuum chamber, dewar and cold-finger mount for LN2-cooled Ti-Sapph crystal	15	1	e							-
steering optics & mounts	0.0075	40	c,e							-
Spectra Physics 409-08 scanning autocorrelator	19.9	1	v							-
Rees Spectrum analyzer	5	1	c							-
Tektronix 100 MHz digital scope	1	2	c							-
Power meter and head (e.g Spectra 407A-1)	1.945	1	v							-
500 MHz oscilloscope	16	1	c							-
delay generator (eg stanford DG 535)	5.4	1	c							-
Interferometric Pulse Analyzer (e.g KM Labs FROG)	17	1	c							-
photodiode monitors (eg Thorlabs Det 210)	0.013	10	c							-
misc optics (e.g. filters, irises,lenses, waveplates, polarizers)	15	1	e							-
enclosure	15	1	e							-
Nonlinear frequency synthesis set-ups (OPA/SFG/DFG/white light cont.)	120	2	e					240.0		240.0
THz Spectroscopy Exptl Station	70	1						70.0		70.0
vacuum system for user stations	20	2	e					40.0		40.0
turbo-pump station	15	2	e					30.0		30.0
Ultrafast System	**290.75**	**1**					290.8			290.8
sub-10 fsec oscillator	35	1	c,e							-
1 KHz diode pumped Nd:YLF pump laser	99.5	1	v							-
Spectra Physics Millenia Vs-J oscillator pump laser	53	1	v							-
multi-pass amplifier	30	1	e							-
hollow-fiber chirped-mirror compressor	30	1	e							-
interferometric autocorrelator	20	1	e							-
chiller	3.25	1	v							-
Rees Spectrum analyzer	5	1	c							-
enclosure	15	1	e							-
Power Amplifier	300	1	e					300.0		300.0
Monochromator	37	2	v					74.0		74.0
Streak Camera (Hamamatsu FESCA)	187.52	1	v					187.5		187.5
optical tables and legs	25	5	c					125.0		125.0
Cambridge Research & Instrumentation pulse LCD pulse shaper SLM-256	16.3	2	c					32.6		32.6
grating, optics & mounts for pulse shaper	10	2	e					20.0		20.0
Vacuum chamber for ultrafast XUV/SXR expts	80	1	e					80.0		80.0
Infrared viewers	1.2	4	c					4.8		4.8
Lock-In amplifier	10	2	c					20.0		20.0
Personal Computers	3	5	e					15.0		15.0
Data Acquisition Electronics	6	3	e					18.0		18.0
Software	35	1	e					35.0		35.0
picomotor driver	4	2	c					8.0		8.0
picomotor mounts	1.5	15	c					22.5		22.5
misc electronics (signal amplifiers, filters, signal analyzers & processors, attenuators, e	35	1	e					35.0		35.0
5 GHz digital oscilloscope	39	1	c					39.0		39.0
500 MHz oscilloscope	16	1	c					16.0		16.0
laser safety glasses	0.45	15	c					6.8		6.8
ND filters	0.1	25	c					2.5		2.5
variable ND filters	1.1	4	c					4.4		4.4
interference filters	0.2	12	c					2.4		2.4
trays for cable, water transport	3	1	e					3.0		3.0
cables	0.015	200	c					3.0		3.0
storage cabinets	0.15	15	e					2.3		2.3
laboratory tables	0.4	7	e					2.8		2.8
misc optics	25	1	e					25.0		25.0
Power meter and head (e.g Spectra 407A-1)	1.945	1	v					1.9		1.9

	2004	2005	2006	2007	2008	TOTAL
TOTAL	-	-	1,016.3	1,466.5	-	2,482.7

BNL CENTER FOR FUNCTIONAL NANOMATERIALS
MATERIAL ESTIMATE BACK-UP
DOLLARS X 1000

WBS NAME: Electron Microscopy

WBS NO: 1.2.3

C = CATALOG PRICE
E = ENG'RG ESTIMATE
V = VENDOR QUOTE

DESCRIPTION	UNIT PRICE	QTY	***	QA	2004	2005	2006	2007	2008	TOTAL
										-
200kV high-resolution TEM/STEM	4571.36	1	V				4,571.4			4,571.4
										-
TEM	1538.08	1	V				1,538.1			1,538.1
										-
										-
TEM Sample Preparation Equipment	499.638	1	V					499.6		499.6
										-
Scanning Electron Microscope FEG	709.44	1	V				709.4			709.4
										-
Lab Hardware, Computers, & Electronics									50.0	50.0
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
TOTAL					-	-	6,818.9	499.6	50.0	7,368.5

BNL CENTER FOR FUNCTIONAL NANOMATERIALS
MATERIAL ESTIMATE BACK-UP
DOLLARS X 1000

WBS NAME: Materials Synthesis

WBS NO: 1.2.4

C = CATALOG PRICE
E = ENG'RG ESTIMATE
V = VENDOR QUOTE

DESCRIPTION	UNIT PRICE	QTY	***	QA	2004	2005	2006	2007	2008	TOTAL
Expt. Xray diffractometer (Tabletop)	71.94	1	V					71.9		71.9
										-
Molecular Beam Epitaxy (MBE)	754.44	1	V				754.4			754.4
										-
Xray Supplies: Tubes, attachments, etc	20	1	E					20.0		20.0
										-
Arc Furnace (tri-arc)	91.025	1	V				91.0			91.0
										-
Crystalox ZoneRef/Bridgeman/induction	438.12	1	V				438.1			438.1
										-
Thermal measurement Lab (TGA, DTA, DSC)	130.628	1	V				130.6			130.6
										-
SQUID Magnetometer (MPMS)	323.56	1	V				323.6			323.6
										-
Surface profiler (Dektak)	100	1	V				100.0			100.0
										-
Metallographic Microscope	42.842	1	V				42.8			42.8
Metallographic Accessories	20	1	E,C					20.0		20.0
Metallographic Lab Equipment			C					24.7		24.7
										-
Vacuum Evaporator	47.85	1	C					47.9		47.9
										-
Pumping System	16.81	3	C,E					50.4		50.4
										-
Pulsed Laser Dep. System	446.8	1	V,C				446.8			446.8
										-
Circulator, spincoater, visometer, centrifuge	35.1	1	V,C,E					35.1		35.1
										-
BET -- Surface Area by Adsorption	37.1	1	V					37.1		37.1
										-
High Pressure Liquid Chromatography (HPLC)	51.819	1	V					51.8		51.8
										-
High Energy RHEED (for MBE)	63.55	1	V			63.6				63.6
High Energy RHEED (for MBE or PLD)	50.4	1	V				50.4			50.4
Scanning Electron Microscope FEG										-
										0
Glove Boxes	13.7847	2	C					27.6		27.6
Glove Boxes	16.1525	1	C					16.2		16.2
Lab Hardware, Computers, & Electronics	65	1	E					65.0		65.0
TOTAL					-	63.6	2,377.8	467.6	-	2,909.0

BNL CENTER FOR FUNCTIONAL NANOMATERIALS
MATERIAL ESTIMATE BACK-UP
DOLLARS X 1000

WBS NAME: Proximal Probes

WBS NO: 1.2.5

C = CATALOG PRICE
E = ENG'RG ESTIMATE
V = VENDOR QUOTE

DESCRIPTION	UNIT PRICE	QTY	***	QA	2004	2005	2006	2007	2008	TOTAL
UV-VIS Raman Microscope (Renishaw)	**196.275**	**1**	**V**					**196.3**		196.3
Research Raman Spectrometer	93.994									-
Raman Imaging Upgrade Kit	25.087									-
Excitation Kit	23.333									-
Kinematic Grating	3.379									-
Motorized XYZ Mapping Stage	22.927									-
Tunable NExT Filter Assembly	27.555									-
										-
AFM/NSOM Aurora III (Veeco)	224.35	1	V				224.4			224.4
										-
FT-IR, FT-Raman, IR Microscope (Bruker)	151.313	1	V					151.3		151.3
										-
UV/VIS/NIR Spectrometer (Varian Cary 5000)	83.75	1	V					83.8		83.8
										-
Combination Optical Microscope and	93.261	1	V				93.3			93.3
UltraObjective SPM Head (Accurion)										-
										-
Raman Spectroscopy System:										-
Intracavity double cw Ar-ion laser (Coherent)	120	1	E				120.0			120.0
CCD Camera	30	1	E				30.0			30.0
0.75m Monochromator	50	1	E				50.0			50.0
										-
UHV, Variable Temperature, Scanning Tunneling	399.36	1	V				399.4			399.4
Microscope (Joel)										-
										-
UHV, Low Temperature Scanning Tunneling	601.89	1	V				601.9			601.9
Microscope (Omicron)										-
										-
Environmental, Combination STM/AFM (Digital)	115.875	1	V					115.9		115.9
										-
LEEM	950	1	V,E			950.0				950.0
										-
UHV Nanoprobe (Omicron)	1187.27	1	V				1,187.3			1,187.3
										-
Combination Near-Field SPM (Nanonics)	121.549	1	V				121.5			121.5
										-
										-
Laboratory Hardware, computers, electronics,	100	1	E			30	40	30		100.0
optics										-
										-
										-
										-
										-
										-
										-
TOTAL					-	980.0	2,867.7	577.2	-	4,424.9

BNL CENTER FOR FUNCTIONAL NANOMATERIALS
MATERIAL ESTIMATE BACK-UP
DOLLARS X 1000

WBS NAME: Theory & Computing

WBS NO: 1.2.6

C = CATALOG PRICE
E = ENG'RG ESTIMATE
V = VENDOR QUOTE

DESCRIPTION	UNIT PRICE	QTY	***	QA	2004	2005	2006	2007	2008	TOTAL
150 Processor Linux Farm	1.094	150	V				164.1			164.1
High End Nodes	3.015	25	V				75.4			75.4
Disk Storage	3.57917	5.8	V				20.8			20.8
Switch	20	1	E				20.0			20.0
										-
Software:										-
Materials Studio (Materials version)	49.99	1	V					50.0		50.0
Materials Studio (Chemistry version)	49.99	1	V					50.0		50.0
Additional Software	22	1	E					22.0		22.0
										-
Lab Hardware, Computers, & Electronics	20	1	E						20.0	20.0
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-

	2004	2005	2006	2007	2008	TOTAL
TOTAL	-	-	280.2	122.0	20.0	422.2

BNL CENTER FOR FUNCTIONAL NANOMATERIALS
MATERIAL ESTIMATE BACK-UP
DOLLARS X 1000

WBS NAME: CFN Endstations at NSLS

WBS NO: 1.2.7

C = CATALOG PRICE
E = ENG'RG ESTIMATE
V = VENDOR QUOTE

DESCRIPTION	UNIT PRICE	QTY	***	QA	2004	2005	2006	2007	2008	TOTAL
End Station X9 - Small Angle Scattering:			E							-
Area Detector			E				325.0			325.0
Detector & High Speed Electronics			E				150.0			150.0
Soller slit System			E				25.0			25.0
Optics			E				100.0			100.0
Chamber			E				150.0			150.0
Optical Microscope			E				30.0			30.0
Motorized slit, Table, Detector Arm and Controls			E				150.0			150.0
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
										-
TOTAL					-	-	930.0	-	-	930.0

WBS 1.1 PROJECT SUPPORT COST SUMMARY (FY 02 Dollars)

WBS 1.1.1 PROJECT MANAGEMENT			
WBS 1.1.1.1 PROJECT MANAGEMENT – Design Phase			
2% of WBS 1.1.2.1, & 1.3	$491,928		
WBS 1.1.1.2 PROJECT MANAGEMENT – Construction Phase			
2% of WBS 1.1.2.2, & 1.3	507,089		
WBS 1.1.1 PROJECT MANAGEMENT TOTAL			**$999,017**
WBS 1.1.2 PROJECT ENGINEERING			
WBS 1.1.2.1 PROJECT ENGINEERING EP – Design Phase			
2% of WBS 1.3.1 – Improvements to land	16,029		
2% of WBS 1.3.2 – Buildings	409,375		
2% of WBS 1.3.3 – Utilities	66,524		
1% of WBS 1.4 – Standard Equipment	10,097		
WBS 1.1.2.1 SUB-TOTAL:	$502,025		
WBS 1.1.2.1 PROJECT ENGINEERING A/E – Design Phase			
8% of WBS 1.3.1 – Improvements to land	64,116		
10% of WBS 1.3.2 – Buildings	2,046,873		
6% of WBS 1.3.3 – Utilities	199,572		
3% of WBS 1.4 – Standard Equipment	30,292		
WBS 1.1.2.1 SUB-TOTAL:	$2,340,853		
WBS 1.1.2.1 TOTAL:		**$2,842,878**	
WBS 1.1.2.2 PROJECT ENGINEERING – Construction Phase			
3% of WBS 1.3.1 – Improvements to land	24,043		
3% of WBS 1.3.2 – Buildings	614,062		
3% of WBS 1.3.3 – Utilities	99,786		
2% of WBS 1.4 – Standard Equipment	20,194		
WBS 1.1.2.2 TOTAL:		**$758,085**	
WBS 1.1.2 PROJECT ENGINEERING TOTAL			**$3,600,963**
WBS 1.1 PROJECT SUPPORT TOTAL: (FY 02 Dollars)			**$4,599,980**

WBS 1.3 CONSTRUCTION (FY02 Dollars)

WBS 1.3.1 - IMPROVEMENTS TO LAND		
From Detailed Cost Estimate	$745,533	
Prime Contractor Mark-up @ 7.5%	55,915	
WBS 1.3.1 - Subtotal		**$801,448**
WBS 1.3.2 - BUILDING		
From Detailed Cost Estimate		
Building-Architectural	$10,908,586	
Building-Mechanical	4,023,349	
Building-EMCS Controls	522,844	
Building-Chiller-Mechanical	864,262	
Building-Chiller Electrical	117,059	
Building-Plumbing	768,636	
Building-Fire Protection	414,128	
Building-Electrical	1,421,814	
Prime Contractor Mark-up @ 7.5%	1,428,051	
WBS 1.3.2 - Subtotal		**$20,468,728**
WBS 1.3.3 - UTILIITIES		
From Detailed Cost Estimate		
Mechanical	$1,051,397	
Electrical	2,042,750	
Prime Contractor Mark-up @ 7.5%	232,061	
WBS 1.3.3 - Subtotal		**$3,326,208**
WBS 1.3 CONSTRUCTION TOTAL (FY02 Dollars)		**$24,596,384**

WBS 1.4 STANDARD EQUIPMENT (FY02 Dollars)

WBS 1.4 - STANDARD EQUIPMENT		
From Detailed Cost Estimate	$939,274	
Prime Contractor Mark-up @ 7.5%	70,446	
WBS 1.4 - Subtotal		**$1,009,719**
WBS 1.4 STANDARD EQUIPMENT TOTAL (FY02 Dollars)		**$1,009,719**

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: OD DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - ARCHITECTURAL

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
1.0 FOUNDATION														
Grade Beam Form	03310	700	3200	1	1,130	CY	0	0.00	0	7.90	8,927	0.47	531	9,458
Grade Beam Conc.	03300	220	0350	1	1,130	CY	0	75.50	85,315	0.00	0	0.00	0	85,315
Retaining Wall	02830	100	3200	1	200	LF	0	207.00	41,400	345.00	69,000	68.00	13,600	124,000
Interior Footings Form	03110	430	6100	1	56	EA	0	13.80	773	45.50	2,548	0.00	0	3,321
Interior Footings Conc	03310	240	3850	1	311	CY	0	92.00	28,612	40.00	12,440	0.44	137	41,189
Epoxy coated reinf. St.	03210	200	0100	1	460	Cwt	0	25.50	11,730	0.00	0	0.00	0	11,730
Foundation dampprofing	03060	850	0050	1	1,130	CY	0	4.25	4,803	0.00	0	0.00	0	4,803
Exterior Footings Form	03110	430	6100	1	47	EA	0	13.80	649	45.50	2,139	0.00	0	2,787
Exterior Footings Conc	03310	240	3850	1	43	CY	0	92.00	3,956	40.00	1,720	0.44	19	5,695
Exterior Pier Form	03110	455	0100	1	47	EA	0	21.00	987	58.50	2,750	0.00	0	3,737
Exterior Pier Conc	03310	240	3850	1	87	CY	0	92.00	8,004	40.00	3,480	0.44	38	11,522
Reinforcing Steel	03210	600	0500	1	48	Ton	0	535.00	25,680	520.00	24,960	0.00	0	50,640
2.0 SLAB ON GRADE														
Expansion joint	03150	250	2550	1	1,440	LF	0	5.95	8,568	0.80	1,152	0.00	0	9,720
Slab Reinforcing	03210	600	0600	1	131	Ton	0	535.00	70,085	475.00	62,225	0.00	0	132,310
Epoxy coated reinf. St.	03210	200	0100	1	500	Cwt	0	25.50	12,750	0.00	0	0.00	0	12,750
6" Slab on grade	03310	240	4820	1	28,316	SF	0	1.35	38,227	0.58	16,423	0.01	283	54,933
15" Slab on grade	03310	240	4950	1	16,000	SF	0	3.48	55,680	0.78	12,480	0.01	160	68,320
3.0 SUPERSTRUCTURE														
Columns	B1010	208	4200	1	2,281	LF	0	34.00	77,554	5.95	13,572	0.00	0	91,126
Column Firerproofing	B1010	271	3550	1	2,281	LF	0	2.50	5,703	15.45	35,241	0.00	0	40,944
Beam Firerproofing	B1010	271	3700	1	2,914	LF	0	1.68	4,896	2.68	7,810	0.00	0	12,705
Metal Siding Support	B2010	154	5000	1	29,004	SF	0	1.37	39,735	2.05	59,458	0.00	0	99,194
Beam & Girder System	B1010	241	3750	1	30,418	SF	0	8.10	246,386	3.50	106,463	0.00	0	352,849
2ndFlr: Metal Deck/Conc	B1010	258	1400	1	40,557	SF	0	2.81	113,965	2.01	81,520	0.00	0	195,485
2ndFlr: Add 4" concrete	B1010	258	1400	1	40,557	SF	0	0.83	33,662	1.30	52,724	0.00	0	86,386
Roof: Open web joist, bm.	B1020	108	2800	1	36,316	SF	0	2.13	77,353	1.06	38,495	0.00	0	115,848
North Stair: Steel w/conc.	C2010	110	0780	1	2	FLT	0	5450.00	10,900	1600.00	3,200	0.00	0	14,100
South Stair: Steel w/conc.	C2010	110	0780	1	2	FLT	0	5450.00	10,900	1600.00	3,200	0.00	0	14,100
Vibration pads	05050	820	0400	1	2,515	SF	0	101.00	254,015	27.50	69,163	0.00	0	323,178
3.0 SUPERSTRUCTURE - PENTHOUSE														
Columns	B1010	208	4400	1	792	LF	0	35.00	27,720	5.95	4,712	0.00	0	32,432
Column Firerproofing	B1010	271	3550	1	792	LF	0	2.50	1,980	15.45	12,236	0.00	0	14,216
Beam Firerproofing	B1010	271	3700	1	971	LF	0	1.68	1,631	2.68	2,602	0.00	0	4,234
Metal Siding Support	B2010	154	5000	1	6,156	SF	0	1.37	8,434	2.05	12,620	0.00	0	21,054
Beam & Girder System	B1010	241	3750	1	10,139	SF	0	8.10	82,126	3.50	35,487	0.00	0	117,612
PthFlr: Metal Deck/Conc	B1010	258	1400	1	8,000	SF	0	2.81	22,480	2.01	16,080	0.00	0	38,560
PthFlr: Add 4" concrete	B1010	258	1400	1	8,000	SF	0	0.83	6,640	1.30	10,400	0.00	0	17,040
Roof: Open web joist, bm.	B1020	108	2800	1	8,000	SF	0	2.13	17,040	1.06	8,480	0.00	0	25,520
North Stair: Steel w/conc.	C2010	110	0780	1	1	FLT	0	5450.00	5,450	1600.00	1,600	0.00	0	7,050

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: OD DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - ARCHITECTURAL

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
Vibration pads	05050	820	0400	1	2,650	SF	0	101.00	267,650	27.50	72,875	0.00	0	340,525
4.0 EXTERIOR CLOSURE														
Metal Siding Panel	B2010	146	4800	1	25,830	SF	0	7.95	205,349	4.03	104,095	0.00	0	309,443
Metal Siding Penthouse	B2011	147	4800	1	7,665	SF	0	7.95	60,937	4.03	30,890	0.00	0	91,827
Doors: Double	B2030	105	3700	1	3	EA	0	1650.00	4,950	390.00	1,170	0.00	0	6,120
Overhead Door	B2030	105	5100	1	2	EA	0	1800.00	3,600	820.00	1,640	0.00	0	5,240
Doors: Aluminum	B2030	105	6500	1	4	EA	0	1550.00	6,200	1125.00	4,500	0.00	0	10,700
Windows: Aluminum	B2020	102	8850	1	385	EA	0	650.00	250,250	110.00	42,350	0.00	0	292,600
Tubular Alum. Framing	B2020	118	2100	1	1,200	SF	0	21.00	25,200	13.25	15,900	0.00	0	41,100
5.0 ROOFING														
Asphalt mineral fiber	B3010	105	5300	1	44,316	SF	0	1.16	51,407	1.36	60,270	0.00	0	111,676
Flashing: Roof edge Alum	B3010	420	1800	1	1,090	LF	0	10.50	11,445	7.75	8,448	0.00	0	19,893
Insulation	B3010	320	2700	1	44,316	SF	0	1.49	66,031	0.36	15,954	0.00	0	81,985
6.0 INTERIOR CONSTRUCTION														
Concrete Partitions	C1010	102	1910	1	10,040	SF	0	2.29	22,992	7.10	71,284	0.00	0	94,276
Drywall Partitions	C1010	124	6250	1	122,568	SF	0	1.33	163,015	2.58	316,225	0.00	0	479,241
Interior glazed openings	C1010	150	1160	1	24	EA	0	1175.00	28,200	875.00	21,000	0.00	0	49,200
Toilet Partitions	C1030	110	0420	1	12	EA	0	585.00	7,020	187.00	2,244	0.00	0	9,264
3' Interior doors & frames	C1020	122	2020	1	109	EA	0	218.00	23,762	156.00	17,004	0.00	0	40,766
6' Interior doors & frames	C1020	122	2180	1	30	EA	0	330.00	9,900	260.00	7,800	0.00	0	17,700
Hinges	C1020	124	0160	1	169	EA	0	9.85	1,665	0.00	0	0.00	0	1,665
Locksets	C1020	124	0400	1	139	EA	0	72.00	10,008	37.50	5,213	0.00	0	15,221
Closer	C1020	124	0560	1	35	EA	0	127.00	4,445	62.50	2,188	0.00	0	6,633
Push Pull	C1021	124	0780	1	4	EA	0	120.00	480	34.00	136	0.00	0	616
Panic devices	C1022	124	0880	1	6	EA	0	630.00	3,780	74.50	447	0.00	0	4,227
Paint wall	C3010	105	0120	1	132,608	SF	0	0.10	13,261	0.34	45,087	0.00	0	58,348
Ceramic Tile	C3010	105	1940	1	360	SF	0	2.30	828	3.26	1,174	0.00	0	2,002
Resilient tile	C3020	410	1300	1	79,873	SF	0	1.17	93,451	0.86	68,691	0.00	0	162,142
Ceiling Tile	C3030	105	6000	1	79,873	SF	0	1.96	156,551	1.10	87,860	0.00	0	244,411
7.0 CONVEYING SYSTEMS														
Passenger elevator	D1010	140	2500	1	1	EA	0	84500	84,500	22900	22,900	0.00	0	107,400
Freight elevator	D1010	140	7000	1	1	EA	0	118000	118,000	23700	23,700	0.00	0	141,700
8.0 SPECIAL CONSTRUCTION (CLEAN ROOMS)														
Clean rm. access flooring	10270	150	0400	1	3,500	SF	0	24.50	85,750	1.01	3,535	0.00	0	89,285
Vinyl covering	10270	150	0700	1	3,500	SF	0	5.25	18,375	0.00	0	0.00	0	18,375
Approach ramp	11620	350	1200	1	50	SF	0	28.00	1,400	8.00	400	0.00	0	1,800
Panelized wall system	13035	200	7100	1	4,927	SF	0	35.00	172,445	0.00	0	0.00	0	172,445
Ceiling grid support	13035	200	2800	1	3,500	SF	0	0.00	0	6.50	22,750	0.00	0	22,750
Ceiling panel	13035	200	3020	1	3,500	SF	0	1.40	4,900	0.00	0	0.00	0	4,900
HEPA filter	13035	200	6240	1	314	EA	0	360.00	113,040	0.00	0	0.00	0	113,040

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: OD DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - ARCHITECTURAL

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
2nd Fl. Clean Room 1000	13035	200	1110	1	2	EA	0	9450.00	18,900	1325.00	2,650	0.00	0	21,550
HEPA filter	13035	200	6240	1	27	EA	0	360.00	9,720	0.00	0	0.00	0	9,720
10 SPECIALTIES														
Computer access flooring	10270	350	0300	1	1,150	SF	0	24.50	28,175	1.01	1,162	0.00	0	29,337
Vinyl covering	10270	150	0700	1	1,150	SF	0	5.25	6,038	0.00	0	0.00	0	6,038
Approach ramp	11620	350	1200	1	50	SF	0	28.00	1,400	8.00	400	0.00	0	1,800
Shielding Panel Radio freq.	13091	700	0150	1	5,700	SF	0	31.00	176,700	3.31	18,867	0.00	0	195,567
11 EQUIPMENT														
Projection screen	11130	500	0700	1	2	EA	0	1500	3,000	120.00	240	0.00	0	3,240
Movie equipment	11136	600	2600	1	2	EA	0	8825	17,650	0.00	0	0.00	0	17,650
Sound system	11136	600	3700	1	2	EA	0	2625	5,250	315.00	630	0.00	0	5,880
Lab base cabinet	11620	350	0300	1	1,207	LF	0	289	348,823	26.50	31,986	0.00	0	380,809
Lab center aisle cabinet	11620	350	0300	1	296	LF	0	289	85,544	26.50	7,844	0.00	0	93,388
Lab counter top	11620	350	1600	1	1,503	LF	0	31	45,842	6.85	10,296	0.00	0	56,137
Fume Hood	11620	350	2100	1	165	LF	0	1250	206,250	282.00	46,530	0.00	0	252,780
Service fixture	11620	350	2300	1	75	EA	0	43	3,225	0.00	0	0.00	0	3,225
Glassware washer	11620	350	2600	1	5	EA	0	7675	38,375	570.00	2,850	0.00	0	41,225
Utility tables	11620	350	3000	1	160	LF	0	109	17,440	16.00	2,560	0.00	0	20,000
SUB-TOTAL DIRECT COSTS							0		4,548,904		1,999,047		14,768	6,562,719
GENERAL CONDITIONS	10%						0		454,890		199,905		1,477	656,272
SUB-TOTAL							0		5,003,794		2,198,952		16,245	7,218,991
OVERHEAD & PROFIT								10%	500,379	56.30%	1,238,010	10%	1,625	1,740,014
SUB-TOTAL							0		5,504,174		3,436,962		17,870	8,959,005
CITY-INDEX								2.70%	148,613	52.40%	1,800,968			1,949,581
TOTAL:							0		5,652,786		5,237,930		17,870	10,908,586
SUB-CONTRACTORS ESTIMATED COSTS:														**10,908,586**

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: RS DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - MECHANICAL

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
DIV. 15 MECHANICAL														
Mechanical Space											0			
Steam Piping	15107	620	2080	1	700	LF	0	5.15	3,605	11.00	7,700	1.70	1,190	12,495
Presure Reducing Valve	15120	640	1040	1	2	EA.	0	1100.00	2,200	72.50	145	0.00	0	2,345
Chilled Water Pumps	D3020	330	1040	1	2	EA.	0	8825.00	17,650	5325.00	10,650	0.00	0	28,300
Chilled Water Piping	15107	620	2130	1	500	L.F.	0	15.70	7,850	22.50	11,250	2.22	1,110	20,210
Pipe Insulation - Chilled Wate	15082	200	6960	1	500	L.F.	0	3.56	1,780	4.01	2,005	0.00	0	3,785
Pipe Insulation - Steam	15082	200	7150	1	500	L.F.	0	3.55	1,775	2.68	1,340	0.00	0	3,115
Air Handling Units-Lab	D3040	110	1040	1	4	EA.	0	18700.00	74,800	11200.00	44,800	0.00	0	119,600
Air Handling Units-VAV	D3040	112	1030	1	2	EA.	0	21900.00	43,800	10600.00	21,200	0.00	0	65,000
Air Handling Units-Clean Rm	D3040	110	1040	1	4	EA.	0	18700.00	74,800	11200.00	44,800	0.00	0	119,600
Air Conditioning - Ductwork	15810	600	0580	1	8,100	LB	0	0.31	2,511	2.76	22,356	0.00	0	24,867
Duct Insualtion	15082	200	3344	1	5,000	SF	0	0.48	2,400	3.21	16,050	0.00	0	18,450
Steam-HW Heat Xchanger	D3040	610	1040	1	1	EA.		77000.00	77,000	21900.00	21,900	0.00	0	98,900
Hot Water Piping	15107	420	1260	1	6,700	LF		7.50	50,250	7.20	48,240	0.00	0	98,490
Hot Water Piping Insulation	15082	200	7150	1	6,700	LF		3.55	23,785	2.68	17,956	0.00	0	41,741
Humidifiers	15750	500	1010	1	15	Ea.		1725.00	25,875	104.00	1,560	0.00	0	27,435
First Floor														
Air Conditioning - Ductwork	15810	600	0580	1	75,000	LB		0.31	23,250	2.76	207,000	0.00	0	230,250
Duct Insulation	15082	200	3344	1	25,000	SF		0.31	7,750	3.21	80,250	0.00	0	88,000
Variable Volume Boxes	D3040	134	1050	1	15	EA		2125.00	31,875	3625.00	54,375	0.00	0	86,250
Diffusers	15850	300	1180	1	136	EA		242.00	32,912	40.00	5,440	0.00	0	38,352
Registers	15850	700	5281	1	136	EA		106.00	14,416	25.50	3,468	0.00	0	17,884
Clean Room Ceiling	13035	200	2800	1	2,740	SF	17,810		0		0	0.00	0	0
Fume Hood Ductwork	15810	600	1060	1	22,500	LB		0.96	21,600	3.35	75,375	0.00	0	96,975
Fume Hood Fan	15830	100	5040	1	18	EA		2400.00	43,200	129.00	2,322	0.00	0	45,522
Reheat Coils	15761	700	0340	1	15	EA		640.00	9,600	68.00	1,020	0.00	0	10,620
Unit Heaters	D3050	130	1010	1	4	EA		1325.00	5,300	965.00	3,860	0.00	0	9,160
Second Floor														
Air Conditioning - Ductwork	15810	600	0580	1	96,000	LB		0.31	29,760	2.76	264,960	0.00	0	294,720
Duct Insulation	15082	200	3344	1	32,000	SF		0.31	9,920	3.21	102,720	0.00	0	112,640
Variable Volume Boxes	D3040	134	1050	1	17	EA		2125.00	36,125	3625.00	61,625	0.00	0	97,750
Diffusers	15850	300	1180	1	128	EA		242.00	30,976	40.00	5,120	0.00	0	36,096
Registers	15850	700	5281	1	128	EA		106.00	13,568	25.50	3,264	0.00	0	16,832
Fume Hood Ductwork	15810	600	1060	1	12,000	LB		0.96	11,520	3.35	40,200	0.00	0	51,720
Fume Hood Fan	15830	100	5040	1	12	EA		2400.00	28,800	129.00	1,548	0.00	0	30,348
Reheat Coils	15761	700	0340	1	14	EA		640.00	8,960	68.00	952	0.00	0	9,912
									0		0	0.00	0	0
Toilet & Kitchen Exhaust														
Ductwork	15810	600	0580	1	1,500	LB		0.31	465	2.76	4,140	0.00	0	4,605
Registers	15850	700	5281	1	8	EA		106.00	848	25.50	204	0.00	0	1,052

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: RS DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - MECHANICAL

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
Fans	15830	100	7100	1	2	EA		300.00	600	92.50	185	0.00	0	785
									0		0	0.00	0	0
Heat Recovery							25,000							25,000
SUB-TOTAL DIRECT COSTS							42,810		771,526		1,189,980		2,300	2,006,616
GENERAL CONDITIONS	10%						4,281		77,153		118,998		230	200,662
SUB-TOTAL							47,091		848,679		1,308,978		2,530	2,207,278
OVERHEAD & PROFIT								10.00%	84,868	54.20%	709,466	10%	253	794,587
SUB-TOTAL							47,091		933,546		2,018,444		2,783	3,001,865
CITY-INDEX								(0.0)	(1,867)	50.70%	1,023,351			1,021,485
TOTAL:							47,091		931,679		3,041,795		2,783	4,023,349
SUB-CONTRACTORS ESTIMATED COSTS:														**4,023,349**

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: CPC 12/15/2002

W.B.S. - 1.3.2 BUILDING - EMCS Controls

DESCRIPTION	MEANS SOURCE			ADJ	QUANT	UNIT	LUMP SUM		MATERIAL		LABOR		EQUIP.		TOTAL
	DIV.	SEC.	LINE				INCL. OH&P TOTAL	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	
building automation															
duct/ pipe sensor	13832	200	0120	1	135	EA.	347	46,818	0.00	0	0.00	0	0.00	0	46,818
space sensor	13832	200	0130	1	43	EA.	622	26,755	0.00	0	0.00	0	0.00	0	26,755
duct humidity	13832	200	0150	1	15	EA.	653	9,792	0.00	0	0.00	0	0.00	0	9,792
space humidity	13832	200	0150	1	15	EA.	1,000	14,994	0.00	0	0.00	0	0.00	0	14,994
duct static pressure	13832	200	0160	1	6	EA.	530	3,180	0.00	0	0.00	0	0.00	0	3,180
space static pressure	13832	200	0190	1.5	4	EA.	1,000	6,000	0.00	0	0.00	0	0.00	0	6,000
analog outputs material in mux	13832	200	1000	1	0	EA.	286	0	0.00	0	0.00	0	0.00	0	0
analog output pneumatic	13832	200	1030	1	95	EA.	602	57,171	0.00	0	0.00	0	0.00	0	57,171
analog output electric	13832	200	1040	1	0	EA.	357	0	0.00	0	0.00	0	0.00	0	0
status alarm freeze	13832	200	2110	1	10	EA.	408	4,080	0.00	0	0.00	0	0.00	0	4,080
status diff pressure air	13832	200	2130	1	30	EA.	561	16,830	0.00	0	0.00	0	0.00	0	16,830
status diff pressure water	13832	200	2140	1	4	EA.	796	3,182	0.00	0	0.00	0	0.00	0	3,182
digital on/off maintained	13832	200	2220	1	26	EA.	561	14,586	0.00	0	0.00	0	0.00	0	14,586
controller 16 point	13832	200	3214	1	19	EA.	3,060	58,140	0.00	0	0.00	0	0.00	0	58,140
controller vav box incl space	13832	200	3266	1	32	EA.	791	25,296	0.00	0	0.00	0	0.00		25,296
color graphic screen	13832	200	4300	1	37	EA.	459	16,983	0.00		0.00	0			16,983
communication trunk cable	13832	200	4400	1	1,500	lf	4	5,355	0.00		0.00				5,355
engineering labor no drafting	13832	200	0580	1	250	pt	78	19,380	0.00	0	0.00	0	0.00	0	19,380
calibration labor	13832	200	4600	1	250	pt	78	19,380	0.00	0	0.00	0	0.00	0	19,380
startup/checkout	13832	200	4700	1	250	pt	117	29,325	0.00	0	0.00	0	0.00	0	29,325
drafting	13832	200	4800	1	160	asreq	120	19,200	0.00	0	0.00	0	0.00	0	19,200
# 18 twisted pair wiring in emt	13832	200	5010	1	15	clf	357	5,355	0.00	0	0.00	0	0.00	0	5,355
custom programming	13832	200	8260	1	1	ls	16,000	16,000	0.00	0	0.00	0	0.00	0	16,000
pressure trans rosemount	13832	200		1	2	EA.		0	1600.00	3,200	450.00	900	0.00	0	4,100
flow meter ultrasonic	13832	200		1	1	EA.		0	4800.00	4,800	950.00	950	0.00	0	5,750
alarm hoods/clean rms	13832	200		1	34	EA	300	10,200	0.00	0	0.00	0	0.00	0	10,200
reheat valves	13838	200	8190	1	29	EA		0	110.00	3,190	13.05	378	0.00	0	3,568
main air line 3/8 copper	13836	200	4800	1	25	clf		0	233.00	5,825	286.00	7,150		0	12,975
computer/software	13832	200	04100	1	1	EA	06120	6,120		0		0		0	6,120
3/4 chilled water mixing valves	13832	200	8070	1	4	EA		0	133.00	532	14.40	58		0	590
SUB-TOTAL DIRECT COSTS								434,122		17,547		9,436		0	461,105
GENERAL CONDITIONS 10%								43,412		1,755		944		0	46,111
SUB-TOTAL								477,534		19,302		10,380		0	507,216
OVERHEAD & PROFIT									10.00%	1,930	54.20%	5,626	10%	0	7,556
SUB-TOTAL								477,534		21,232		16,005		0	514,771
CITY-INDEX									(0.0)	(42)	50.70%	8,115			8,073
TOTAL:								477,534		21,189		24,120		0	522,844
SUB-CONTRACTORS ESTIMATED COSTS:															**522,844**

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: GL DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - MECHANICAL REPLACEMENT OF CHILLERS

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
CHILLED WATER SYSTEM														
800 TON Centrifugal Chiller (1000 Tons)	D30	140	1030	1.00	1	EA				44,000	44,000			$44,000
800 TON Centrifugal Chiller	15620	600	0310	1.00	1	EA		244,500	244,500					$244,500
800 TON Centrifugal Chiller ($225-$250/ Ton)	Trane C			1.00	800	Tons								
800 TON Cooling Tower	D30	310	1050	1.00	1	EA		66,500	66,500	24,900	24,900			$91,400
SUPPORTS				1.00	8	EA		250	2,000	500	4,000			$6,000
CHW PUMP 1300 GPM (Richardson Process& Gen Construction) 300' HD 150HP HSC	15-3			1.00	1	EA		11,100	11,100	535	535			$11,635
STANDBY 1300 GPM CHW PUMPS (Richardson Process& Gen Construction) 300' HD 150HP HSC	15-3			1.00	1	EA		11,100	11,100	535	535			$11,635
CW PUMP 2400 GPM (Richardson Process & Gen Construction) 100HP HSC 125' HD	15-3			1.00	1	EA		7,800	7,800	1,680	1,680			$9,480
CONDENSER WATER														
12" SCH40 WELDED PIPE	15107	620	2160	1.00	510	FT		48.00	24,480	33.50	17,085	4.21	2,147	$43,712
12" SCH40 TEE weld	15107	660	3480	1.15	2	EA		305.00	610	505.00	1,162	50	100	$1,872
12" SCH40 ELB 90 weld	15107	660	3170	1.00	12	EA		217.00	2,604	320.00	3,840	26.5	318	$6,762
12" FLNG weld neck	15107	660	6550	1.00	4	EA		164.00	656	161.00	644	16	64	$1,364
12" 150# Lugged Wafer Butterfly Control Valve	15110	200	0850	1.15	1	EA		1800	1,800	179.00	206			$2,006
12" BOLT SET	15107	660	0720	1.00	2	EA		32.00	64	68.50	137			$201
1" THREDOLETS	15107	660	5634	1.00	4	EA		5.70	23	26.00	104	4	16	$143
CA TESTING 6"-10" 250'-500'	15950	700	0340	1.10	2	EA				715.00	1,573			$1,573
CHILLED WATER														
10" SCH40 WELDED PIPE	15107	620	2150	1.00	320	FT		43.00	13,760	33.50	10,720	3.33	1,066	$25,546
10" SCH40 TEE weld	15107	660	3470	1.00	2	EA		202.00	404	405.00	810	40	80	$1,294
10" SCH40 ELB 90 weld	15107	660	3160	1.00	12	EA		151.00	1,812	268.00	3,216	26.5	318	$5,346
10" FLNG weld neck	15107	660	6540	1.00	4	EA		113.00	452	134.00	536	13.3	53	$1,041
10" 150# Lugged Wafer Butterfly Control Valve	15110	200	0850	1.15	1	EA		1400	1,400	179.00	206			$1,606
10" BOLT SET	15107	660	0710	1.00	2	EA		30.00	60	64.00	128			$188
1" THREDOLETS	15107	660	5634	1.00	4	EA		5.70	23	26.00	104	4	16	$143
CA TESTING 6"-10" 200'	15950	700	0360	1.00	1	EA				985.00	985			$985
DOMESTIC COLD WATER														

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: GL DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - MECHANICAL REPLACEMENT OF CHILLERS

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
2" K COPPER PIPE	15107	420	1260	1.00	200	FT		7.50	1,500	7.20	1,440			$2,940
2" COPPER ELBOW	15107	460	0160	1.00	6	FT		8.60	52	26.00	156			$208
2" BALL VALVE	15110	160	1500	1.00	2	EA		37.50	75	26.00	52			$127
2" BRZ STRAINER	15120	820	0180	1.00	1	EA		53.50	54	22.50	23			$76
CONTROLS DDC														
Communications Buss	13832	200	5010	1.03	100	FT		3.57	357					$357
16 POINT CONTROLL.	13832	200	3214	1.03	1	EA		3060	3,060					$3,060
ANALOG OUTPUTS	13832	200	1040	1.03	4	EA		357.00	1,428					$1,428
ANALOG OUTPUTS (MD 1&2 & VAV)	13832	200	1040	1.03	4	EA		357.00	1,428					$1,428
ENG. LABOR	13832	200	4500	1.03	16	EA		77.52	1,240					$1,240
Callibration START-UP CHECK (	13832	200	4700	1.03	16	EA		117.50	1,880					$1,880
DC POWER SUPPLY	13832	200	1040	1.03	1	EA		139.00	139	13	13			$152
SENSORS - A.I. (avg. run 50' in 1/2" emt)														
PRESSURE SENSOR (PT)	13832	200	0176	1.00	2	EA		918.00	1,836					$1,836
WATER TEMP SENSOR (TT)	13832	200	0172	1.00	2	EA		612.00	1,224					$1,224
Pneumatic -Electronic Transducer	13832	200	1010	1.00	2	EA		591.60	1,183					$1,183
D.O. (avg. run 50' in 1/2" emt)														
START-STOP	13832	200	2210	1.00	1	EA		326.40	326					$326
D.I. STATUS ALARMS (avg. run 50' in 1/2" emt)														
Pneumatic Tubing 1/4 " OD	15838	200	9416	1.03	400	FT		0.83	332	2	997			$1,329
DRAFTING	157	422	0120	1.03	16	HR				29	478			$478
BALANCING														
Balancing Pump	15955	900	1000	1.00	3	EA		192.19	577					$577
INSULATION					.									
12" PIPE 1"TH	15082	200	7010	1.00	750	FT		5.95	4,463	5.35	4,013			$8,475
10" PIPE 1"TH	15082	200	7000	1.00	500	FT		5.95	2,975	5.35	2,675			$5,650
1"DIA 1"TH.	15082	200	6870	1.03	100	FT		1.78	178	2.10	216			$394
DEMOLITION					.									
Refrigerant Removal				1.00	1800	LBs		0.50	900	1.00	1,800			$2,700
Chiller Removal	15050	300	3600	1.00	18	Tons				475.00	8,550			$8,550
Piping 8" to 14"	15055	600	2150	1.00	200	LF				9.60	1,920			$1,920
SUB-TOTAL DIRECT COSTS									416,354		139,437		4,178	559,969
GENERAL CONDITIONS 10%									41,635		13,944		418	55,997
SUB-TOTAL									457,989		153,381		4,596	615,966

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: GL DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - MECHANICAL REPLACEMENT OF CHILLERS

DESCRIPTION	MEANS SOURCE DIV.	SEC.	LINE	ADJ.	QUANT	UNIT	INCL. OH&P TOTAL	MATERIAL UNIT COST	MATERIAL TOTAL	LABOR UNIT COST	LABOR TOTAL	EQUIP. UNIT COST	EQUIP. TOTAL	TOTAL
OVERHEAD & PROFIT								10.00%	45,799	54.20%	83,133	10%	460	129,391
SUB-TOTAL									503,788		236,514		5,055	745,357
CITY-INDEX								-0.20%	(1,008)	50.70%	119,912			118,905
TOTAL:									502,780		356,426		5,055	864,262
SUB-CONTRACTORS ESTIMATED COSTS:														**864,262**

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: DD/JW DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - ELECTRICAL REPLACEMENT OF CHILLERS

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
ELECTRICAL DEMO	16055													
RGT-1-1/4"-2"	16055	300	0120	1	150	LF				1.42	213			$213
RGT-2-4""	16055	300	0140	1	150	LF				1.88	282			$282
EMT-1-1/4"-2"	16055	300	0220	1	150	LF				0.87	131			$131
TERMINATIONS	QUOTE			1	75	EA				7.5	563			$563
MOTOR CONT. CENTER	QUOTE			1	1	EA				1500	1,500	200	200	$1,700
GROUNDING SYSTEM														
# 4/0 GROUND CABLE	16060	800	1000	1	2	CLF		147	294	99.5	199			$493
# 250 GROUND CABLE	16060	800	1200	1	4	CLF		175	700	118	472			$1,172
CADWELDS TO STEEL 4/0	16060	800	2740	1	8	EA		6.75	54	40.5	324			$378
CADWELDS TOWIRE 4/0	16060	800	2760	1	12	EA		5.4	65	40.5	486			$551
CADWELD MOLDS	16060	800	2790	1	4	EA		84	336					$336
WIRING METHODS														
TERM.LUG 600V, #16-#10	16120	230	0050	1	75	EA		0.44	33	5.65	424			$457
CONTROL CABLE #14/2	16120	280	0020	1	15	CLF		11.05	166	31.5	473			$638
CONTROL CABLE #14/10	16120	280	0400	1	20	CLF		47	940	59	1,180			$2,120
No. 12 AWG WIRE THWN	16120	900	0940	1	12	CLF		5.3	64	26	312			$376
No. 10 AWG WIRE THWN	16120	900	0960	1	10	CLF		8.3	83	28.5	285			$368
No. 4 AWG WIRE XHHW	16120	900	3100	1	8	CLF		42.5	340	53.5	428			$768
No. 2 AWG WIRE XHHW	16120	900	3120	1	8	CLF		63.5	508	63	504			$1,012
No. 2/0 AWG WIRE	16120	900	3180	1	8	CLF		122	976	98	784			$1,760
No. 4/0 AWG WIRE	16120	900	3220	1	8	CLF		188	1,504	129	1,032			$2,536
No. 250 KCMIL WIRE	16120	900	3240	1	8	CLF		224	1,792	142	1,136			$2,928
No. 500 KCMIL WIRE	16120	900	3320	1	10	CLF		430	4,300	177	1,770			$6,070
CONDUIT AND TUBING														
TO 15 FEET ELEV														
RGS CDT-3/4"	16132	205	1770	1	175	LF		1.94	340	3.55	621			$961
RGS CDT-1"	16132	205	1800	1	75	LF		2.73	205	4.36	327			$532
RGS CDT-2"	16132	205	1870	1	225	LF		5.8	1,305	6.3	1,418			$2,723
RGS CDT-3"	16132	205	1930	1	175	LF		12.2	2,135	11.35	1,986			$4,121
EMT CDT-3/4"	16132	205	5020	1	125	LF		0.57	71	2.18	273			$344
EMT CDT-1"	16132	205	5040	1	125	LF		0.98	123	2.47	309			$431
FLEXIBLE METALLIC CDT														
METAL.FLEX CDT-1-1/4"	16132	320	0300	1	10	FT		1.13	11	4.05	41			$52
METAL.FLEX CDT-1-1/2"	16132	320	0350	1	10	FT		1.47	15	5.65	57			$71
METAL.FLEX CDT-2"	16132	320	0370	1	30	FT		2.17	65	7.1	213			$278
METAL.FLEX CDT-3"	16132	320	0390	1	40	FT		3.25	130	11.35	454			$584
SAFETY SWITCHES														
250V,NEMA1,3P,NF,30A	16410	800	0610	1	1	EA		57	57	89	89			$146

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: DD/JW DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - ELECTRICAL REPLACEMENT OF CHILLERS

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
600V,NEMA1,3P,NF,30A	16410	800	1110	1	1	EA		99	99	89	89			$188
MOTOR CONTR. CNTR	**16440**													
MCC COMPONENTS														
Size 1, FVNR, cb, Nema 12	16440	620	0200	1	1	EA		1025	1,025	109	109			$1,134
Size 2, FVNR, cb, Nema 12	16440	620	1200	1	1	EA		1150	1,150	149	149			$1,299
Size 3, FVNR, cb, Nema 12	16440	620	2400	1	1	EA		2025	2,025	299	299			$2,324
Size 4, FVNR, cb, Nema 12	16440	620	3600	1	2	EA		2725	5,450	380	760			$6,210
Size 5, FVNR, cb, Nema 12	16440	620	4900	1	2	EA		4425	8,850	590	1,180			$10,030
MOTOR CONNECTIONS														
460V, 150 H.P.	16150	275	1610	1	2	EA		56	112	158	316			$428
460V, 100 H.P.	16150	275	1590	1	1	EA		41	41	113	113			$154
460V, 60 H.P.	16150	275	1570	1	1	EA		22	22	74.5	75			$97
CHILLER CONNECTION	16150	275	1620	1	9	EA		97	873	125	1,125			$1,998
PANELS 277/480V MLO														
100 AMP, 24 CIRCUIT	16440	720	2500	1	1	EA		1700	1,700	675	675			$2,375
HEAT TRACING EQUIP.		VENDOR		1	1	LS		750	750	1500	1,500			$2,250
TESTING		QUOTE		1	1	LS				750	750			$750
SUB-TOTAL DIRECT COSTS									38707		25422		200	$64,329
GENERAL CONDITIONS (10%)									3,871		2,542		16	
SUB-TOTAL									42,578		27,964		216	$70,758
OVERHEAD & PROFIT								10%	4,258	49.2%	13,758	10%	22	
SUB-TOTAL									46,836		41,723		238	
CITY-INDEX								3.6%	1,686	63.7%	26,577			
TOTAL:									48,522		68,300		238	$117,059
ESTIMATED SUB-CONTRACTORS TOTAL COSTS:														**$117,059**

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: GB DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - PLUMBING

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTA	TOTAL
FIXTURES														
Toilets														
Lavatory Sink	15400	400	0640	1	8	ea		335.00	2,680	119.00	952		0	3,632
Rough supply, waste, vent	15400	450	3580	1	8	ea		74	592	330	2,640		0	3,232
Urinal	15400	700	3120	1	2	ea		325.00	255	323.00	646		0	901
Rough supply, waste, vent	15400	700	3300	1	2	ea		96.00	192	270.00	540		0	732
Water Closet	15400	900	1050	1	6	ea		630.00	3,780	144.00	864		0	4,644
Rough supply, waste, vent	15400	900	3510	1	6	ea		330.00	1,980	390.00	2,340		0	4,320
Handicap Water Closets	15400	900	3370	1	4	ea		335	1,340	153	612		0	1,952
Rough supply, waste, vent	15400	900	3400	1	4	ea		138	552	268	1,072		0	1,624
seats	15410	800	0260	1	10	ea		30	300	18.00	180		0	480
									0		0			0
Labatories														
Cup sink	15400	600	1660	1	17	ea		100.00	1,700	130.00	2,210		0	3,910
Rough supply, waste, vent	15400	450	3580	1	17	ea		74	1,258	330	5,610		0	6,868
hoods	11600	350	2500	1	8	ea		525.00	4,200	280.00	2,240		0	6,440
Rough supply, waste, vent	15400	450	3580	1	8	ea		74	592	330	2,640		0	3,232
Janitor's Closet														
Service Sink	15400	600	6650	1	2	ea		490.00	980	175.00	350		0	1,330
Rough in - supply, waste, vent	15400	600	6790	1	2	ea		194.00	388	465.00	930		0	1,318
									0		0			0
Lunch Rooms														
Rough-in for Kitchen Units				1	2	ea		85.00	170	415.00	830		0	1,000
Hot water dispensers	15400	400	0160	1	2	ea		310	620	50	100		0	720
Corridors														
Handicap Drinking fountain	15400	900	0160	1	2	ea		620.00	1,240	190.00	380		0	1,620
Rough supply, waste, vent	15400	900	9800	1	2	ea		52.00	104	192.00	384		0	488
Misc.														
Backflow P[illegible]	15140	100	1240	1	1			5625.00	5,625	600.00	600		0	6,225

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: GB DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - PLUMBING

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTA	TOTAL
PIPE & VALVES														
cold water piping	15100	420	1260	1	500	LF		3.3	1,650	6.50	3,250			4,900
Valves & Fittings				1	1	LS	2,500		0		0		0	2,500
cold water piping	15100	420	1180	1	1,000	LF		2.75	2,750	5.75	5,750			8,500
Valves & Fittings				1	1	LS	4,500		0		0		0	4,500
Pipe Insulation	15050	200	8180	1	500	LF		1.65	825	4.60	2,300		0	3,125
valve & Fitting insulation				1	1	LS	1,500		0		0		0	1,500
Pipe Insulation	15050	200	8140	1	1,000	LF		0.6	600	4.55	4,550		0	5,150
valve & Fitting insulation				1	1	LS	2,200		0		0		0	2,200
hot water piping	15100	420	1260	1	500	LF		3.3	1,650	6.50	3,250			4,900
Valves & Fittings				1	1	LS	2,500		0		0		0	2,500
hot water piping	15100	420	1180	1	1,000	LF		2.75	2,750	5.75	5,750			8,500
Valves & Fittings				1	1	LS	4,500		0		0		0	4,500
Pipe Insulation	15050	200	8180	1	500	LF		1.65	825	4.60	2,300		0	3,125
valve & Fitting insulation				1	1	LS	1,500		0		0		0	1,500
Pipe Insulation	15050	200	8140	1	1,000	LF		0.6	600	4.55	4,550		0	5,150
valve & Fitting insulation				1	1	LS	2,200		0		0		0	2,200
Pipe Insulation	15050	200	8360	1	1,500	LF		1.3	1,950	4.55	6,825		0	8,775
valve & Fitting insulation				1	1	LS	2,200		0		0		0	2,200
Air piping	15100	420	1180	1	1,000	LF		2.75	2,750	5.75	5,750		0	8,500
Valves & fittings				1	1	LS	2,500		0		0		0	2,500
Vacuum piping	15100	420	1180	1	1,000	LF		2.75	2,750	5.75	5,750		0	8,500
Valves & fittings				1	1	LS	4,500		0		0		0	4,500
Distilled water piping	15100	420	1180	1	500	LF		2.75	1,375	5.75	2,875		0	4,250
Valves & fittings				1	1	LS	2,500		0		0		0	2,500
Propane piping	15100	620	4810	1	1,000	LF		2	2,000	8.50	8,500		0	10,500
Valves & fittings				1	1	LS	5,000		0		0		0	5,000
Flexible pipe to clean rms.				1	1	LS	8,500		0		0		0	8,500
testing of piping	15950	700	0180	1	7	ea			0	1200.00	8,400		0	8,400
Sanitary piping	15100	320	2160	1	2,000	LF		8.45	16,900	14.00	28,000		0	44,900
fittings				1	1	LS	10,000		0		0		0	10,000
Vent piping	15100	320	2140	1	2,000	LF		6.75	13,500	13.00	26,000		0	39,500
fittings				1	1	LS	10,000		0		0		0	10,000
									0		0		0	0
Roof Drains	15100	300	4340	1	11	EA		285	3,135	130.00	1,430		0	4,565
Drain Piping	15100	520	6760	1	500	LF		5.75	2,875	7.00	3,500		0	6,375
Fittings				1	1	LS	4,500		0		0		0	4,500
pipe Insulation	15050	200	8440	1	500	LF		6.55	3,275	5.00	2,500		0	5,775
testing of piping	15950	700	0180	1	1	ea			0	1200.00	1,200		0	1,200

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW | JOB NUMBER: 9899 | BY: GB | DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - PLUMBING

DESCRIPTION	MEANS SOURCE DIV.	SEC.	LINE	ADJ.	QUANT	UNIT	INCL. OH&P TOTAL	MATERIAL UNIT COST	MATERIAL TOTAL	LABOR UNIT COST	LABOR TOTAL	EQUIP. UNIT COST	EQUIP. TOTAL	TOTAL
SUB-TOTAL DIRECT COSTS							72,700		220,588		168,928		0	462,216
GENERAL CONDITIONS	10%						7,270		22,059		16,893		0	46,222
SUB-TOTAL							79,970		242,647		185,821		0	508,438
OVERHEAD & PROFIT								10.00%	24,265	50.80%	94,397	10%	0	118,662
SUB-TOTAL							79,970		266,911		280,218		0	627,099
CITY-INDEX								-0.20%	(534)	50.70%	142,070			141,537
TOTAL:							79,970		266,378		422,288		0	768,636
SUB-CONTRACTORS ESTIMATED COSTS:														**768,636**

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: SG DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - FIRE PROTECTION

DESCRIPTION	MEANS SOURCE DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	MATERIAL UNIT COST	MATERIAL TOTAL	LABOR UNIT COST	LABOR TOTAL	EQUIP. UNIT COST	EQUIP. TOTAL	TOTAL
FIRE PROTECTION														
First Floor	A8.2	110	1100	1	44,316	SF	0	0.56	24,817	1.48	65,588	0.00	0	90,405
Second Floor	A8.2	110	1240	1	40,873	SF	0	0.44	17,984	1.30	53,135	0.00	0	71,119
Penthouse	A8.2	110	1100	1	7,332	SF	0	0.56	4,106	1.48	10,851	0.00	0	14,957
First floor Standpipe Class 1	A8.2	310	0560	1	1	FLR.	0	1775.00	1,775	2000	2,000	0.00	0	6,875
Second flr. standpipe Class 1	A8.2	310	0580	1	1	FLR.	0	520.00	520	635.00	635	0.07	0	7,280
Penthouse Standpipe Class 1	A8.2	310	0580	1	1	FLR.	0	520.00	520	635.00	635	0.07	0	7,280
Hydrostatic Testing	000	000	0000	1	1	L.S.	20,000	0.00	0	0.00	0	0.00	0	20,000
SUB-TOTAL DIRECT COSTS							20,000		49,722		132,844		0	202,566
GENERAL CONDITIONS 10%							2,000		4,972		13,284		0	20,257
SUB-TOTAL							22,000		54,694		146,128		0	222,823
OVERHEAD & PROFIT								10%	5,469	50.80%	74,233	10%	0	79,703
SUB-TOTAL							22,000		60,164		220,362		0	302,525
CITY-INDEX								-0.20%	(120)	50.70%	111,723			111,603
TOTAL:							22,000		60,043		332,085		0	414,128
SUB-CONTRACTORS ESTIMATED COSTS:														**414,128**

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: JG/JW DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - ELECTRICAL

DESCRIPTION	MEANS SOURCE DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	MATERIAL UNIT COST	MATERIAL TOTAL	LABOR UNIT COST	LABOR TOTAL	EQUIP. UNIT COST	EQUIP. TOTAL	TOTAL
DIV. 16 ELECTRICAL														
(New Structure)														
1st Floor														
Electrical - Power														
480/277V PWR DIST PNL	16440	860	1040	1	2	EA		6500	13,000	2500	5,000			18,000
208/120V PWR DIST PNL	16440	860	1040	1	2	EA		1500	3,000	1500	3,000			6,000
208/120V SUB PNL	16400	500	3800	1	12	EA		274	3,288	236	2,832			6,120
#10 AWG Wire	16120	900	5480	1	250	CLF		16	3,900	27	6,625			10,525
#8 AWG Wire	16120	900	5500	1	100	CLF		23	2,300	33	3,300			5,600
350kcmil Wire	16120	900	3280	1	6	CLF		300	1,800	147	882			2,682
500 kcmil Wire	16120	900	3320	1	6	CLF		425	2,550	165	990			3,540
120v Receptacle	16140	910	2470	1	130	EA		10	1,235	10	1,274			2,509
120v Toggle Switch	16140	910	0500	1	50	EA		7	325	10	490			815
#12 AWG MC Wire	16120	120	9200	1	800	CLF		47	37,200	100	79,600			116,800
3" EMT Conduit	16132	210	0340	1	150	LF		5	773	4	536			1,308
3/4" EMT Conduit	16132	210	0220	1	200	LF		0.42	84	1.04	208			292
12" Cable Tray-Fiberglass	16131	105	0200	1	200	LF		30	6,000	6	1,230			7,230
36" Cable Tray-Fiberglass	16131	105	0700	1	125	LF		54	6,750	9	1,100			7,850
250 kcmil Ground Wire	16060	800	1200	1	50	CLF		199	9,950	110	5,500			15,450
Cadweld	16060	800	2740	1	50	EA		7	338	38	1,875			2,213
Cadweld Molds	16060	800	2790	1	8	EA		84	672					672
Controls	BNL QUOTE			1	1	LS	2,000							
Testing	BNL QUOTE			1	1	LS		500	500	750	750			1,250
Cable Termination	16120	230	2200	1	85	EA		3.54	301	11.00	935			1,236
15 kva UPS	16260	800	0230	1	4	EA		10600	42,400	2950	11,800	610	2440	56,640
Electrical - Comm.														
Comm. Outlet	BNL QUOTE			1	40	EA		12	480	17	680			1,160
Telephone wire	16120	750	2300	1	50	CLF		10	500	33	1,650			2,150
Fiber Optic Cable	BNL QUOTE			1	25	CLF		33	825	48	1,200			2,025
3/4" EMT Conduit	16132	210	0220	1	500	LF		0.42	210	1.04	520			730
12" Cable Tray-Fiberglass	16131	105	0200	1	200	LF		30	6,000	6	1,230			7,230
36" Cable Tray-Fiberglass	16131	105	0700	1	125	LF		54	6,750	9	1,100			7,850
Comm. Panel	BNL QUOTE			1	1	EA		825	825	1,800	1,800			2,625
Electrical - Fire Alarm														
Smoke Detector	13851	65	5200	1	35	EA		75	2,625	43	1,488			4,113
Audible/Visible Device	13851	65	5600	1	8	EA		95	760	50	400			1,160
Manual Pull Station	13851	65	7000	1	2	EA		50	100	33	66			166
Lightning Protector	13101	55	3100	1	8	EA		70	560	40	316			876
#16 AWG FPLR wire	BNL QUOTE			1	15	CLF		33	495	30	450			945
3/4" EMT Conduit	16132	210	0220	1	400	LF		0.42	168	1.04	416			584

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: JG/JW DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - ELECTRICAL

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
Electrical - Lighting														
Flourescent Fixture	16510	440	0600	1	240	EA		56	13,440	56	13,440			26,880
Emergency Lamp Pack	16530	320	0900	1	10	EA		111	1,110	27	265			1,375
Exit Fixture	16530	320	0100	1	10	EA		44	440	40	395			835
Fixture Hangers	16500	300	0420	1	240	EA		12	2,772	22	5,280			8,052
2nd Floor														
Electrical - Power														
480/277V PWR DIST PNL	16440	860	1040	1	2	EA		6500	13,000	2500	5,000			18,000
208/120V PWR DIST PNL	16440	860	1040	1	2	EA		1500	3,000	1500	3,000			6,000
208/120V SUB PNL	16400	500	3800	1	12	EA		274	3,288	236	2,832			6,120
#10 AWG Wire	16120	900	5480	1	250	CLF		16	3,900	27	6,625			10,525
#8 AWG Wire	16120	900	5500	1	100	CLF		23	2,300	33	3,300			5,600
350kcmil Wire	16120	900	3280	1	6	CLF		300	1,800	147	882			2,682
500 kcmil Wire	16120	900	3320	1	6	CLF		425	2,550	165	990			3,540
120v Receptacle	16140	910	2470	1	130	EA		10	1,235	10	1,274			2,509
120v Toggle Switch	16140	910	0500	1	50	EA		7	325	10	490			815
#12 AWG MC Wire	16120	120	9200	1	500	CLF		47	23,250	100	49,750			73,000
3" EMT Conduit	16132	210	0340	1	150	LF		5	773	4	536			1,308
3/4" EMT Conduit	16132	210	0220	1	200	LF		0.42	84	1.04	208			292
12" Cable Tray-Fiberglass	16131	105	0200	1	200	LF		30	6,000	6	1,230			7,230
36" Cable Tray-Fiberglass	16131	105	0700	1	125	LF		54	6,750	9	1,100			7,850
Controls	BNL QUOTE			1	1	LS	2,000							
Testing	BNL QUOTE			1	1	LS		500	500	750	750			1,250
Cable Termination	16120	230	2200	1	85	EA		3.54	301	11.00	935			1,236
15 kva UPS	16260	800	0230	1	4	EA		10600	42,400	2950	11,800	610	2440	56,640
Electrical - Comm.														
Comm. Outlet	BNL QUOTE			1	40	EA		12	480	17	680			1,160
Telephone wire	16120	750	2300	1	50	CLF		10	500	33	1,650			2,150
Fiber Optic Cable	BNL QUOTE			1	30	CLF		33	990	48	1,440			2,430
3/4" EMT Conduit	16132	210	0220	1	500	LF		0.42	210	1.04	520			730
12" Cable Tray	16131	105	0200	1	100	LF		30	3,000	6	615			3,615
36" Cable Tray	16131	105	0700	1	30	LF		54	1,620	9	264			1,884
Comm. Panel	BNL QUOTE			1	1	EA		825	825	1,800	1,800			2,625
Electrical - Fire Alarm														
Smoke Detector	13851	65	5200	1	40	EA		75	3,000	43	1,700			4,700
Audible/Visible Device	13851	65	5600	1	8	EA		95	760	50	400			1,160
Manual Pull Station	13851	65	7000	1	4	EA		50	200	33	132			332
Lightning Protector	13101	55	3100	1	8	EA		70	560	40	316			876
#16 AWG FPLR wire	BNL QUOTE			1	50	CLF		33	1650	30	1500			3,150
3/4" EMT Conduit	16132	210	0220	1	5,000	LF		0.42	2,100	1.04	5,200			7,300

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: JG/JW DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - ELECTRICAL

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
Electrical - Lighting														
Flourescent Fixture	16510	440	0600	1	240	EA		56	13,440	56	13,440			26,880
Emergency Lamp Pack	16530	320	0900	1	10	EA		111	1,110	27	265			1,375
Exterior Fixture	16520	300	2340	1	10	EA		175	1,750	98	980			2,730
Exit Fixture	16530	320	0100	1	10	EA		44	440	40	395			835
Fixture Hangers	16500	300	0420	1	240	EA		12	2,772	22	5,280			8,052
Penthouse														
Electrical - Power														
480V 600A BUS, MCC	16440	860	1040	1	1	EA		12000	12,000	12000	12,000			24,000
208/120V PWR DIST PNL	16440	860	1040	1	1	EA		1500	1,500	1500	1,500			3,000
#10 AWG Wire	16120	900	5480	1	250	CLF		16	3,900	27	6,625			10,525
#8 AWG Wire	16120	900	5500	1	100	CLF		23	2,300	33	3,300			5,600
350kcmil Wire	16120	900	3280	1	20	CLF		300	6,000	147	2,940			8,940
500 kcmil Wire	16120	900	3320	1	20	CLF		425	8,500	165	3,300			11,800
120v Receptacle	16140	910	2470	1	20	EA		10	190	10	196			386
120v Toggle Switch	16140	910	0500	1	5	EA		7	33	10	49			82
#12 AWG MC Wire	16120	120	9200	1	200	CLF		47	9,300	100	19,900			29,200
3" EMT Conduit	16132	210	0340	1	600	LF		5	3,090	4	2,142			5,232
3/4" EMT Conduit	16132	210	0220	1	1,500	LF		0.42	630	1.04	1,560			2,190
12" Cable Tray-Fiberglass	16131	105	0200	1	20	LF		30	600	6	123			723
36" Cable Tray-Fiberglass	16131	105	0700	1	100	LF		54	5,400	9	880			6,280
250 kcmil Ground Wire	16060	800	1200	1	50	CLF		199	9,950	110	5,500			15,450
Cadweld	16060	800	2740	1	10	EA		7	68	38	375			443
Cadweld Molds	16060	800	2790	1	2	EA		84	168					168
Testing	BNL QUOTE			1	1	LS		500	500	750	750			1,250
Cable Termination	16120	230	2200	1	24	EA		3.54	85	11.00	264			349
Electrical - Comm.														
Comm. Outlet	BNL QUOTE			1	4	EA		12	48	17	68			116
Telephone wire	16120	750	2300	1	5	CLF		10	50	33	165			215
Fiber Optic Cable	BNL QUOTE			1	3	CLF		33	99	48	144			243
3/4" EMT Conduit	16132	210	0220	1	200	LF		0.42	84	1.04	208			292
Comm. Panel	BNL QUOTE			1	1	EA		825	825	1,800	1,800			2,625
Electrical - Fire Alarm														
Smoke Detector	13851	65	5200	1	5	EA		75	375	43	213			588

BROOKHAVEN NATIONAL LABORATORY

PLANT ENGINEERING DIVISION

COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: JG/JW DATE: 12/15/2002

W.B.S. - 1.3.2 BUILDING - ELECTRICAL

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
Audible/Visible Device	13851	65	5600	1	4	EA		95	380	50	200			580
Manual Pull Station	13851	65	7000	1	2	EA		50	100	33	66			166
Lightning Protector	13101	55	3100	1	2	EA		70	140	40	79			219
#16 AWG FPLR wire	BNL QUOTE			1	5	CLF		33	165	30	150			315
3/4" EMT Conduit	16132	210	0220	1	200	LF		0.42	84	1.04	208			292
Electrical - Lighting														
Flourescent Fixture	16510	440	0600	1	20	EA		56	1,120	56	1,120			2,240
Emergency Lamp Pack	16530	320	0900	1	4	EA		111	444	27	106			550
Exit Fixture	16530	320	0100	1	4	EA		44	176	40	158			334
Fixture Hangers	16500	300	0420	1	20	EA		12	231	22	440			671
SUB-TOTAL DIRECT COSTS							4,000		389,821		352,429		4,880	751,130
GENERAL CONDITIONS 10%							400		38,982		35,243		488	75,113
SUB-TOTAL							4,400		428,803		387,672		5,368	826,243
OVERHEAD & PROFIT								10%	42,880	57.60%	223,299	10%	537	266,716
SUB-TOTAL							4,400		471,684		610,971		5,905	1,092,959
CITY-INDEX								3.40%	16,037	51.20%	312,817			328,855
TOTAL:							4,400		487,721		923,788		5,905	1,421,814
SUB-CONTRACTORS ESTIMATED COSTS:														**1,421,814**

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: GB DATE: 12/15/2002

W.B.S. - 1.3.3 UTILITIES - MECHANICAL

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
Monitoring Wells									0		0		0	0
Removal of 18 monitoring wells				1	1	LS	18000		0		0		0	18,000
New monitoring wells				1	1	LS	40000		0		0		0	40,000
									0		0		0	0
Sanitary													0	
Temporary pupming setup				1	1	LS	5000		0		0		0	5,000
Removal of manholes	02200	875	0020	1	2	EA			0	202.00	404	55.00	110	514
Removal of piping	02200	875	2960	1	450	LF			0	6.75	3,038	2.50	1,125	4,163
Modifications to exist manholes				1	2	LS	3500		0		0		0	3,500
									0		0		0	0
New manholes	02600	200	0700	1	2	EA		450.00	900	1200.00	2,400	125.00	250	3,550
Covers & frames	2600	200	2700	1	2	EA		465.00	930	157.00	314	40.00	80	1,324
New piping	02500	730	2260	1	500	LF		35.00	17,500	30.00	15,000	12.00	6,000	38,500
Testing of piping	200	700	0200	1	1	EA			0	1000.00	1,000		0	1,000
connections to existing manholes				1	1	LS	5000		0		0		0	5,000
									0		0		0	0
Excavation	2300	900	0500	1	1,500	CY			0	2.75	4,125	2.50	3,750	7,875
shoring				1	1	LS	4000		0		0		0	4,000
backfilling	2300	900	3020	1	1,500	CY			0	1.25	1,875	1.00	1,500	3,375
tamping	2300	460	0400	1	1,500	CY			0	4.50	6,750	1.50	2,250	9,000
									0		0		0	0
Storm									0		0		0	0
Temporary pupming setup				1	1	LS	5000		0		0		0	5,000
Remval of Lift Station				1	1	LS	5500		0		0		0	5,500
Removal of manholes	02200	875	0020	1	6	EA			0	202.00	1,212	55.00	330	1,542
Removal of catch basins	02200	875	0020	1	8	EA			0	202.00	1,616	55.00	440	2,056
Removal of piping	02200	875	2960	1	2,000	LF			0	6.75	13,500	2.50	5,000	18,500
Modifications to exist manholes				1	1	LS	2000		0		0		0	2,000
Modifications to exist catch basins				1	1	LS	1500		0		0		0	1,500
									0		0		0	0
New Lift Station	11300	700	0200	1	1	EA		43,000	43,000	51000.00	51,000	12000	12,000	106,000
[illegible]				[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: GB DATE: 12/15/2002

W.B.S. - 1.3.3 UTILITIES - MECHANICAL

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
Excavation	2300	900	0500	1	1,500	CY			0	2.75	4,125	2.50	3,750	7,875
shoring				1	1	LS	4000		0		0		0	4,000
backfilling	2300	900	3020	1	1,500	CY			0	1.25	1,875	1.00	1,500	3,375
tamping	2300	460	0400	1	1,500	CY			0	4.50	6,750	1.50	2,250	9,000
									0		0		0	0
Water									0		0		0	0
Remove existing piping & valves	02200	875	2900	1	600	LF			0	4.65	2,790	1.25	750	3,540
Removal of fire hydrants	020	554	0900	1	2	EA			0	225.00	450	90.00	180	630
									0		0		0	0
Modifications to building supply				1	1	LS	5000		0		0		0	5,000
Drill & tap water main	02500	820	4850	1	1	EA		1,200.00	1,200	500.00	500	100.00	100	1,800
New curb stops	2050	900	3300	1	2	EA		550.00	1,100	350.00	700	120.00	240	2,040
New post indicator valves	2050	400	5020	1	2	EA		500.00	1,000	125.00	250	20.00	40	1,290
New fire hydrants	02050	400	2080	1	4	EA		1,200.00	4,800	115.00	460	25.00	100	5,360
New piping	2500	350	1440	1	1,000	LF		15.00	15,000	12.00	12,000	1.00	1,000	28,000
Testing of piping	15959	700	0360	1	1	LS			0	1500.00	1,500		0	1,500
									0		0		0	0
Excavation	2300	900	0500	1	1,500	CY			0	2.75	4,125	2.50	3,750	7,875
backfilling	2300	900	3020	1	1,500	CY			0	1.25	1,875	1.00	1,500	3,375
tamping	2300	460	0400	1	1,500	CY			0	4.50	6,750	1.50	2,250	9,000
									0		0		0	0
Stean & Condensate									0		0		0	0
Removal of existing pipe & valves	00020	554	3000	1	250	LF			0	6.50	1,625	2.50	625	2,250
									0		0		0	0
New steam manhole				1	1	LS	6000		0		0		0	6,000
Covers & frames	2600	200	2700	1	2	EA		465.00	930	157.00	314	40.00	80	1,324
Grates				1	4	LS	1200		0		0		0	1,200
Piping & valves in manhole				1	1	LS	40000		0		0		0	40,000
New steam piping - conduit pipe	2500	550	730	1	800	LF		32.00	25,600	36.00	28,800	4.50	3,600	58,000
valves & fittings				1	1	LS	25000		0		0		0	25,000
new condendsate piping - conduit pipe	2500	550	0720	1	800	LF		25.00	20,000	30.00	24,000	3.50	2,800	46,800
valves & fittings				1	1	LS	23000		0		0		0	23,000
Testing of piping	15959	700	0360	1	2	LS			0	1500.00	3,000		0	3,000
									0		0		0	0
Excavation	2300	900	0500	1	600	CY			0	2.75	1,650	2.50	1,500	3,150
shoring				1	1	LS	4000		0		0		0	4,000
backfilling	2300	900	3020	1	600	CY			0	1.25	750	1.00	600	1,350
tamping	2300	460	0400	1	600	CY			0	4.50	2,700	1.50	900	3,600
									0		0		0	0

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW　　JOB NUMBER: 9899　　BY: GB　　DATE: 12/15/2002

W.B.S. - 1.3.3 UTILITIES - MECHANICAL

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
Chilled water									0		0		0	0
New chilled water supply pipe - conduit pipe	2500	550	730	1	200	LF		32.00	6,400	36.00	7,200	4.50	900	14,500
valves & fittings				1	1	LS	6000		0		0		0	6,000
new chilled water return - conduit pipe	2500	550	730	1	200	LF		32.00	6,400	36.00	7,200	4.50	900	14,500
valves & fittings				1	1	LS	6000		0		0		0	6,000
Air pipe	2500	920	3020	1	200	LF		6.00	1,200	3.50	700	1.00	200	2,100
valves & fittings				1	1	LS	23000		0		0		0	23,000
Testing of piping	15959	700	0360	1	2	LS			0	1500.00	3,000		0	3,000
Excavation	2300	900	0500	1	900	CY			0	2.75	2,475	2.50	2,250	4,725
shoring				1	1	LS	4000		0		0		0	4,000
backfilling	2300	900	3020	1	900	CY			0	1.25	1,125	1.00	900	2,025
tamping	2300	460	0400	1	900	CY			0	4.50	4,050	1.50	1,350	5,400
									0		0		0	0
Propane									0		0		0	0
Propane Tank				1	1	LS	8000		0		0		0	8,000
Piping	15100	620	4850	1	300	LF		3.76	1,128	11.50	3,450		0	4,578
Excavation	2300	900	0500	1	250	CY			0	2.75	688	2.50	625	1,313
shoring				1	1	LS	2500		0		0		0	2,500
backfilling	2300	900	3020	1	250	CY			0	1.25	313	1.00	250	563
tamping	2300	460	0400	1	250	CY			0	4.50	1,125	1.50	375	1,500
SUB-TOTAL DIRECT COSTS							178700		160,988		243,051		25,355	608,094
GENERAL CONDITIONS	10%						17870		16,099		24,305		2,536	60,809
SUB-TOTAL							196570		177,087		267,356		27,891	668,903
OVERHEAD & PROFIT								10.00%	17,709	56.30%	150,521	10%	2,789	171,019
SUB-TOTAL							196570		194,795		417,878		30,680	839,923
CITY-INDEX								-0.20%	(390)	50.70%	211,864			211,475
TOTAL:							196570		194,406		629,742		30,680	1,051,397
SUB-CONTRACTORS ESTIMATED COSTS:														**1,051,397**

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
ELECTRICAL COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: JOB NUMBER: 9899 BY: J.G./JW DATE: 12/15/2002

W.B.S.1.3.3 - UTILITIES - ELECTRICAL

	MEANS SOURCE							MATERIAL		LABOR		EQUIP.		
DESCRIPTION	DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL	TOTAL
DIV. 16 ELECTRICAL														
(Site)														
Removal/Relocation														
SMES Trailer/Cable	BNL QUOTE			1	1	LS		40,000	40,000	60,000	60,000			100,000
Relocation Lift Station	BNL QUOTE			1	1	LS				45,000	45,000	2000	2000	47,000
Remove comm mh/db/tel cbl	BNL QUOTE			1	1	LS		5,000	5,000	15,000	15,000	2000.00	2000	22,000
Electrical - Power														
XMFR - 13800-480/277V Sil.	BNL QUOTE			1	2	EA		26,500	53,000	4,825	9,650	1000	2000	64,650
XMFR - 13800-208/120V Sil.	BNL QUOTE			1	2	EA		26,500	53,000	4,825	9,650	1000	2000	64,650
Primary Switch - 15 kv	16330	760	0700	1	4	EA		17,000	68,000	1,800	7,200	385	1540	76,740
6 Way SF6 Switch	BNL QUOTE			1	1	LS		28,000	28,000	12,500	12,500	900	900	41,400
Secondary Switchgear	BNL QUOTE			1	2	LS		65,000	130,000	5,000	10,000	1500	3000	143,000
Cable - 15 kv 500 kcmil	BNL QUOTE			1	60	CLF		570	34,200	220	13,200			47,400
Cable - 15 kv #4/0	BNL QUOTE			1	10	CLF		315	3,150	200	2,000			5,150
Cable - 15 kv #2/0	BNL QUOTE			1	12	CLF		290	3,480	180	2,160			5,640
250 kcmil Ground Wire	16060	800	1200	1	20	CLF		199	3,980	110	2,200			6,180
Cadweld	16060	800	2740	1	30	EA		7	203	38	1,125			1,328
Cadweld Molds	16060	800	2790	1	6	EA		84	504					504
Manhole	2580	300	1800	1	3	EA		1,625	4,875	745	2,235	435	1305	8,415
Foundations	3310	240	3900	1	60	CY		84	5,040	9	558	0.36	21.6	5,620
DuctbanK 4-5" PVC	2580	300	5840	1	550	LF		7	3,933	8	4,153			8,085
Concrete for Ductbank	2220	875	2100	1	70	CY				30	2,100	3.1	217	2,317
Rebar for Ductbank	2580	300	7860	1	4	TN		560	2,240	460	1,840			4,080
Excav. For Ductbank	2315	440	2070	1.5	650	LF				4.36	4,251	0.29	188.5	4,440
Install New Lift Station	BNL QUOTE			1	1	LS		6,500	6,500	12,500	12,500	1250.00	1250	20,250
Metering	BNL QUOTE			1	1	LS		4,500	4,500	7,300	7,300			11,800
Electrical - Comm.														
Manhole	2580	300	1800	1	3	EA		1,625	4,875	745	2,235	435	1305	8,415
DuctbanK 6-4" PVC	2580	300	5800	1	700	LF		10	7,000	11	7,700			14,700
DuctbanK 4-4" PVC	2580	300	5600	1	800	LF		6	4,800	8	6,040			10,840
DuctbanK 2-4" PVC	2580	300	5400	1	100	LF		3	300	4	400			700
Concrete for Ductbank	2220	875	2100	1	140	CY				30	4,200	3.1	434	4,634
Rebar for Ductbank	2580	300	7860	1	8	TN		560	4,480	460	3,680			8,160
Excav. For Ductbank	2315	440	2070	1.5	1,700	LF				4.36	11,118	0.29	493	11,611
Cable - Fiber Optic	BNL QUOTE			1	1,500	LF		6	9,000	12	18,000			27,000
Cable - Tel 500 pr Nano Bldg	BNL QUOTE			1	1,250	LF		8	10,000	15	18,750			28,750
Cable - Telephone 900 pr	BNL QUOTE			1	1,500	LF		11	16,500	20	30,000			46,500
Cable - Telephone 600 pr	BNL QUOTE			1	1,500	LF		9	13,500	16	24,000			37,500
Cable - Telephone 100 pr	BNL QUOTE			1	1,500	LF		2	3,000	8	12,000			15,000
Tel. cable splicing/cutover	BNL QUOTE			1	1	ls		3,500	3,500	28,000	28,000			31,500
Data/Comm Equipment	BNL QUOTE			1	1	LS		100,000	100,000	50,000	50,000			150,000

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
ELECTRICAL COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: JOB NUMBER: 9899 BY: J.G./JW DATE: 12/15/2002

W.B.S.1.3.3 - UTILITIES - ELECTRICAL

DESCRIPTION	MEANS SOURCE DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	MATERIAL UNIT COST	MATERIAL TOTAL	LABOR UNIT COST	LABOR TOTAL	EQUIP. UNIT COST	EQUIP. TOTAL	TOTAL
Electrical - Fire Alarm														
Valve - PIV Controls	BNL QUOTE			1	2	EA		850	1,700	1,800	3,600			5,300
Electrical - Lighting														
Lighting - Roadway	16500	300	2650	1	10	EA		535	5,350	132	1,320			6,670
Poles - Aluminum	16500	300	4600	1	10	EA		745	7,450	53	530	52.00	208	8,188
Bracket Arms	16500	300	5400	1	10	EA		122	1,220	33	330			1,550
Footings for Poles	3300	700	1900	2	20	CY				9	360	0.90	8.1	368
Conduit - 1-1/2" RGS	16132	205	1850	1	500	LF		4	2,000	5	2,500			4,500
Cable - #8 AWG THHN	16120	900	1300	1	30	CLF		16	480	33	990			1,470
Cable - #10 AWG THHN	16120	900	1250	1	20	CLF		9	180	27	540			720
SUB-TOTAL DIRECT COSTS									644,939		450,915		18,870	1,114,724
GENERAL CONDITIONS	10%								64,494		45,091		1,887	111,472
SUB-TOTAL									709,433		496,006		20,757	1,226,196
OVERHEAD & PROFIT								10%	70,943	49.20%	244,035	10%	2,076	317,054
SUB-TOTAL									780,376		740,041		22,833	1,543,250
CITY-INDEX								3.60%	28,094	63.70%	471,406			499,500
TOTAL:									808,470		1,211,447		22,833	2,042,750
SUB-CONTRACTORS ESTIMATED COSTS:														**2,042,750**

BROOKHAVEN NATIONAL LABORATORY
PLANT ENGINEERING DIVISION
COST ESTIMATE

BNL CENTER FOR FUNCTIONAL NANOMATERIALS

PROJECT TITLE: BNL CENTER FOR FUNCTIONAL NANOMATERIALS

BUILDING: NEW JOB NUMBER: 9899 BY: OD DATE: 12/15/2002

W.B.S. - 1.4 STANDARD EQUIPMENT

DESCRIPTION	MEANS SOURCE DIV.	SEC.	LINE	ADJ.	QUANT.	UNIT	INCL. OH&P TOTAL	MATERIAL UNIT COST	MATERIAL TOTAL	LABOR UNIT COST	LABOR TOTAL	EQUIP. UNIT COST	EQUIP. TOTAL	TOTAL
DIV. 12 FURNISHINGS														
Shades	E2010	320	0140	1	385	EA	0	9.85	3,792	0.93	358	0.00	0	4,150
Office furniture	E2020	210	0510	1	110	EA	0	2,325	255,750	0.00	0	0.00	0	255,750
Office computers	BNL quote			1	110	EA	0	3,500	385,000	0.00	0	0.00	0	385,000
Display cabinets	12310	200	0100	1	5	EA	0	1250.00	6250	0.00	0	0.00	0	6,250
Lab Chairs	12510	600	2250	1	41	EA	0	1325.00	54325	0.00	0	0.00	0	54,325
Lab Stools	12510	600	2280	1	113	EA	0	150.00	16950	0.00	0	0.00	0	16,950
Conference chairs	12510	550	1200	1	50	EA	0	395.00	19750	33.00	1,650	0.00	0	21,400
Conference tables	12540	100	2020	1	7	EA	0	1400.00	9800	0.00	0	0.00	0	9,800
SUB-TOTAL DIRECT COSTS							0		751,617		2,008		0	753,625
GENERAL CONDITIONS 10%							0		75,162		201		0	75,363
SUB-TOTAL							0		826,779		2,209		0	828,988
OVERHEAD & PROFIT								10%	82,678	56.30%	1,244	10%	0	83,921
SUB-TOTAL							0		909,457		3,452		0	912,909
CITY-INDEX								2.70%	24,555	52.40%	1,809			26,365
TOTAL:							0		934,012		5,262		0	939,274
SUB-CONTRACTORS ESTIMATED COSTS:														**939,274**